DEPARTMENT OF AGRICULTURE, VICTORIA.

ADDITIONS

TO THE

FUNGI ON THE VINE IN AUSTRALIA

(WITH 80 FIGURES).

BY

D. McALPINE, Government Vegetable Pathologist,

ASSISTED BY

GERALD H. ROBINSON.

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PLATE I.

MAGNIFIED PHOTOS. OF "AUREO GRAPE-ROT" AND "SQUIRT BERRY."

Fig.

1. Aureobasidium, with conidiophores producing abundance of conidia, and springing from green tubercular base. The delicate fringe all round the top represents the hyaline conidia-bearing filaments, and the dark patches immediately beneath are the dark-green tubercles, while underlying that is the disorganized tissue of the grape. To the extreme right are small pieces of detached epidermis.

14. Transverse section of outer portion of grape showing tubercles of *Phoma tuberculata* with perithecia. The brown disorganized tissue of the grape is seen immediately beneath the tubercles, thrown into various folds and depressions. To the extreme right the raised epidermis is still attached to the top of the tubercles by numerous strands of hyphæ ; next there is a tubercle bearing two perithecia, the one over the other. On the elevated portion to the left are two sessile perithecia, then perithecia at different stages of development.

15. Transverse section of same showing elevated tubercles with and without perithecia. The very elevated portion to the left shows colourless tubercles without perithecia, and a portion of the thrust-off epidermis is seen at the top. The rest of the section shows dark-brown or yellowish-brown tubercles, bearing perithecia at their summits, either solitary or in couples.

PLATE 1.

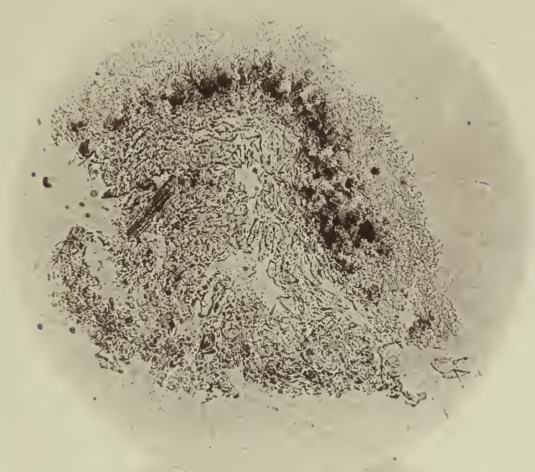
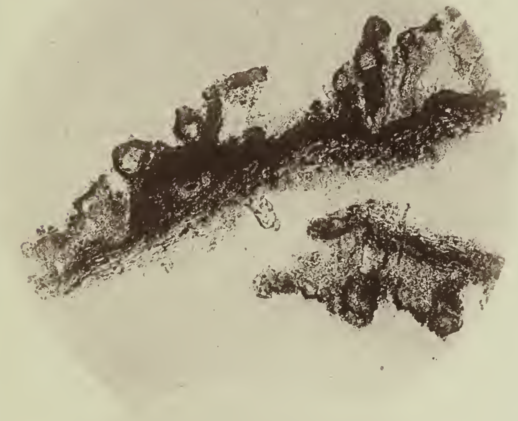


Fig. 1.



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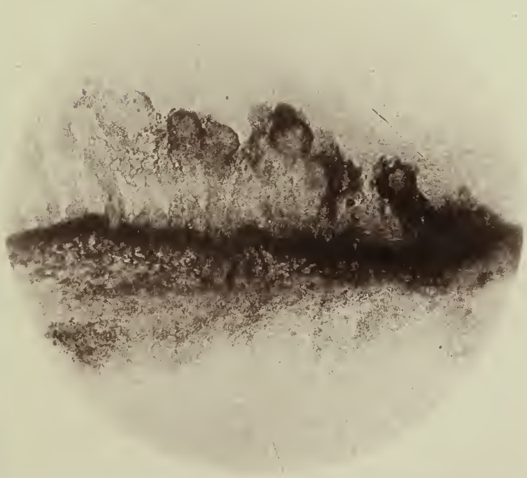


Fig. 15.

PLATE II.

MAGNIFIED PHOTOS. OF "NOBLE ROT," "COLOURED GLŒOSPORIUM," "NIPPLE-LIKE CYTOSPORA," AND "SLENDER-STALKED HENDERSONIA."

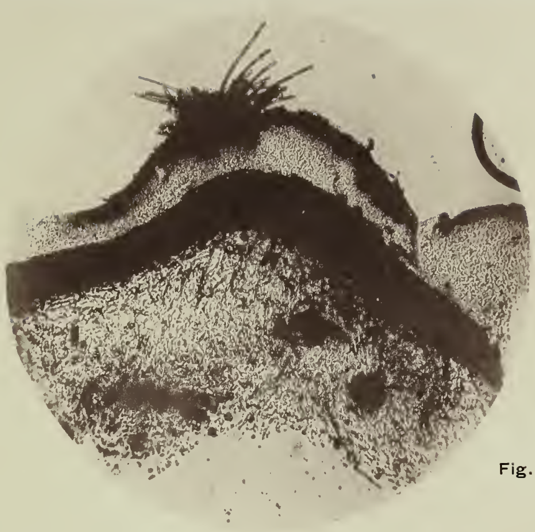
Fig.

34. Section of Sclerotium on grape, showing the Botrytis filaments proceeding from the dark outer rind. The brown and relatively thick disorganized tissue of the skin is also shown, and that of the underlying pulp which is permeated by fungus filaments.

44. Section of skin of grape showing fungus rupturing epidermis and producing sporules (*Glœosporium*).

51. Section of grape-skin (the upper portion of which has become twisted upon itself) showing the spherical, hemispherical, or nipple-shaped perithecia (*Cytospora*).

54. Section of grape-skin showing immersed perithecia with brown disorganized tissue beneath (*Hendersonia*).



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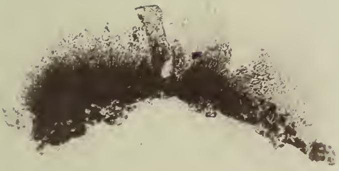

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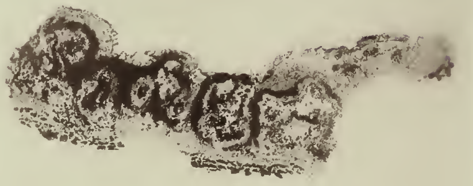

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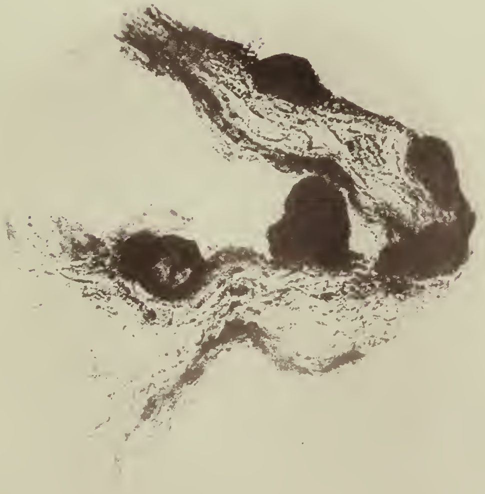

Fig. 51.

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I.—PARASITES.

ADDITIONS TO THE FUNGI ON THE VINE IN AUSTRALIA.

INTRODUCTION.

The cultivation of the vine is now becoming so general, and has attained such importance as a national industry, that everything tending to develop that industry is worthy of attention. Accompanying this extensive planting, there is necessarily also an enlarged area offered for the enemies of the vine to work upon, and so the diseases of the vine have come to be a serious consideration with the grower. Our genial climate and favorable conditions encourage not only a luxuriant growth of the plant, but likewise of those plant parasites which ultimately weaken and often destroy the hosts on which they prey. In the following paper, I will confine myself to the fungi which have recently been found upon the grape vine in Australia, and, where possible, distinguish between those which are parasites and cause the destruction of living tissue and those which are saprophytes only appearing on dead or decaying tissues. It is not always easy to decide between parasite and saprophyte, for some fungi that were for a long time considered only capable of attacking dead tissue are now known to injure the living plant, and some have the inconvenient habit (to the grower) of being able to assume the rôle of both. Thus the Sweet or Noble Rot (*Botrytis cinerea*), which had long been known on the fallen and dead vine leaves, was found to pass from the decaying leaves on the ground to the healthy leaves of various plants and produce "spots" on them, and it is now recognised as causing the "Sweet Rot" of the grape itself.

However, I will place in the list of parasites only those known to attack the living parts of the plant, and to produce decided symptoms, since it is important to specially note those which cause serious damage and are therefore to be carefully studied with a view to proper preventive treatment. As my main object at present is to treat of some fresh additions to the large number of fungi already found upon the vine, I will first give a complete list of all the fungi hitherto found upon the vine in Australia. Then describe and illustrate all the new forms so that they may be recognised, and this will be the first step towards devising measures for their prevention or mitigation. It is not a special purpose of this pamphlet to give remedial measures, but since amid the numerous diseases here mentioned the grower might be puzzled as to which were really the most important from his point of view, I have appended a chart of the principal diseases and the best-known treatment. Although the directions are brief, it is believed that they are sufficiently clear to be followed and acted on by the intelligent grower.

While additions are being made to the vine fungi, it is gratifying to be able to record a reduction at least by one. Mr. Massee, of the Royal Herbarium, Kew, has a paper in the *Annals of Botany*, Vol. IX., No. XXXV., Sept., 1895, pp. 421–429, on "The Spot Disease of Orchids," where it is pointed out that "brunissure" or browning of vine leaves can be caused by heavy dews and a rapid fall of temperature following heavy rain. So that the fungus hitherto credited with causing this, viz., *Plasmodiophora vitis*, Viala and Sauvageau, must now be relegated to obscurity.

When one considers the antiquity of the vine and the amount of attention paid to its diseases both on the Continent of Europe and in America, it is to say the least of it surprising that so many new and undescribed fungi should be found in a comparatively new country like our own. Not only are more fungus diseases of the vine recorded here for the first time than were previously known for Australia altogether, but at least ten new ones have been added. The probabilities are that most of these new fungi will be found in other countries when looked for, still it is likely that some of them are indigenous. It is a fact which has been impressed upon me from the examination of numerous specimens that the parasites of the native vegetation extend their ravages to cultivated plants whenever opportunity offers, and it is a striking illustration of this that the "Sooty Mould" of the Citrus family here is not due to the same fungus as in the older countries of the world, but to a new species probably derived from indigenous plants. Hence the necessity for the proper study of the various fungi which invade native as well as introduced plants, which attack the so-called weeds as well as the cultivated forms. In fact, the diseases of the vine, on account of their great economic importance, are worthy of special study, and it is desirable that the services of a trained assistant be devoted to their investigation and treatment. These can only be properly studied by close and careful observation in the vineyard accompanied by microscopic investigations in the laboratory, and until the colonies combine to have a central Pathologic establishment, where the various diseases of the vine and other plants can be wrought out in detail and their life-history studied, there is little prospect of satisfactory measures being devised for the effectual treatment of many of them.

Of the new parasites recorded for Australia perhaps the most important are the "Aureo Grape-rot" and "Squirt Berry," since they cause a softening and moistening and bursting of the skin of the grape which often results in serious loss.

Botrytis cinerea has already been mentioned, and on the Continent of Europe it is often regarded as a friendly parasite since it causes the "Sweet Rot" and improves the wine, but with us the damp rot which it produces is positively injurious.

The dreaded "Black Rot" has also been recorded by Massee on grapes sent from Victoria in 1893, but its distribution must be very limited, as I have never succeeded in securing a specimen.

The "Downy Mildew" has likewise been determined by Dr. Cooke on leaves sent from a vine growing in the suburbs of Melbourne, but it, too, has never come under my notice. In the accompanying list arranged in the order adopted in the "Systematic Arrangement of Australian Fungi" there are 23 new fungi added, ten of which are new to science, thirteen new to Australia, and one new to Victoria.

Of these 23, fourteen are to be regarded as parasites, giving rise to the particular symptoms recorded in connexion with their description, and while all parasitic fungi are more or less injurious, only about the first six on the list are of practical importance at present.

But even the saprophytes require recognition, as they are often mistaken for or confounded with serious parasitic diseases, and some of them may be found, like the Botrytis, to change their habit of life and become parasites as well.

Only fourteen were previously recorded, and of these nine are parasitic and five non-parasitic, so that there are 37 fungi altogether now known on the vine in Australia—23 parasitic and fourteen non-parasitic. Considering that over 400 species of fungi are known on the grape vine alone, the proportion for Australia is not as yet a large one. The grape itself is a favorite food for the attacks of fungi, since it contains a perfect storehouse of the choicest nourishment in a very convenient form, and no less than 20 out of the 23 parasitic fungi are found upon the succulent berry.

The following tabulated statement will present the above facts in a concrete shape and show the present (July, 1897) numerical strength of the Vine Fungi:—

New Vine Fungi ...	23	Old Vine Fungi ...	14
New to Science ...	10		
New to Australia ...	13		
New to Victoria ...	1 (Fumagine)		
Parasitic	14	Parasitic	9
Non-parasitic ...	9	Non-parasitic ...	5

It will be observed that in a few instances several scientific names included in brackets are given for the same fungus. The first on the list is to be considered the most appropriate one, according to our present knowledge, but the others are given, since the fungus may be referred to in other publications under one or other of these names. The discovery of different stages in the life-history of the same fungus has often necessitated a change of name, and thus several synonyms may arise. Common names are likewise given, but if used alone they are often misleading. Thus, in South Australia, there is a so-called "black rot," which only occurs on grapes allowed to hang on the vines after being cracked with rain. It does no damage to sound grapes, and has no connexion with the deadly disease commonly known by that name. Hence the common name is always accompanied by the scientific name in this publication.

All the additional fungi have been found in Victoria, with the exception of *Sterigmatocystis nigra*, which occurred on grapes sent from West Australia, and of the previously known parasitic fungi only two are confined so far to New South Wales and Queensland, viz., *Pestalozzia uvicola* and *Cercospora viticola*. To have treated at length all the vine diseases in our midst would require a much larger work, but this may be regarded as an instalment of what may afterwards become a complete account of Australian Vine Fungi.

In a paper read by B. T. Galloway, Chief of the Division of Vegetable Physiology and Pathology, United States Department of Agriculture, on "Plant Diseases and the Possibility of lessening their Spread by Legislation," some very pertinent remarks occur regarding the increase of disease. He says—"It needs little argument to prove that the enemies of cultivated plants are steadily increasing, and I think it can be easily shown that they will continue to increase so long as the conditions, for which we are in large part responsible, remain as they are at present. I do not by any means regard this as a calamity. On the contrary, I look upon the fact that our insect and fungus foes are increasing as direct proof that we are progressing; for, as Professor Bailey has said—'Our enemies increase because cultivation induces change of habits in wild organisms; because it presents an ever-increasing variety of food or host-plants; because the food supply is large, and in more or less contiguous areas; and, finally, because the natural equilibrium or tension is destroyed.' It follows, therefore, that the more we put forth our energies to improve our native plants, or to change their habits, the more we endeavour to increase the variety and number of our cultivated vines, trees, and shrubs; the more we extend our orchards, our vineyards, and our fields, just so much more do we disturb the equilibrium in nature, and just so much more must we expect to burden ourselves with the work of maintaining this unstable condition by more or less artificial means. Where an insect or fungus had one chance a hundred years ago to wax strong and spread, it has now a thousand chances, for unbroken orchards and vineyards, and millions of nursery trees, cover the country where then only wild plants grew."

There is a very general impression that the discovery of a new parasitic fungus necessarily means an additional burden to the grower, but it all depends on the nature of the fungus and the character of the measures necessary to cope with it. If it is amenable to treatment by means of applications in use for fungi previously known—for instance, the Bordeaux Mixture—then its presence only serves as an additional reason for using such treatment. And even if it may require special treatment, it is always desirable to know the enemy we have to fight, in order to meet his attacks with the proper weapons, for it is far better to be aware of our danger than to live in blissful ignorance of it. Besides, knowledge in this direction is power, for the very fact that we are aware of it, and know that it is not some mysterious visitation due to the weather or other equally uncontrollable agency, induces us to experiment with some hope of success in finding a remedy. Eternal vigilance is the price the grower must pay for freedom from the devastating fungi. In the technical descriptions of the new fungi, I have endeavoured to meet the requirements of the ordinary grower to a certain extent by giving the general appearances as they present themselves to a careful and constant observer, and the microscopic characters for those who make a special scientific study of the subject. My best thanks are due to Messrs. De Castella, Gow, and Thiele for providing me with specimens, but especially to my honorary assistant, Mr. G. H. Robinson, of Ardmona, who has so aided me in these investigations, both by practical observations in the field and microscopic observations in the laboratory, that his name is associated with my own on the title-page. Also to Professor G. Briosi, of Pavia University, who kindly sent me vine leaves affected with a new variety of *Aureobasidium*, and a publication relating to this fungus by his assistant, Dr. L. Montemartini.

Mr. L. Hart, F.R.M.S., Lecturer on Photography at the Working Men's College, has executed several photo-micrographs of fungi in a style which shows what accuracy can be obtained by this method of illustration.

LIST OF AUSTRALIAN VINE FUNGI.

(*Additions indicated by an Asterisk.*)

Parasites.

*Aureo Grape-rot	Aureobasidium vitis, var. tuberculatum, McAlp.
Black Rot	Guignardia bidwellii, Viala and Ravaz. Phoma uvicola, B. and C.
*Sweet Rot or Noble Rot	Sclerotinia fuckeliana, D. By. Botrytis cinerea, Pers.
Oidium or Powdery Mildew	Uncinula spiralis, Berk. and Cooke Oidium tuckeri, Berk.
Vine Erysiphe	Erysiphe vitigera, Cooke and Mass.
*Blue Mould	Penicillium glaucum, Link.
*Coremium	Coremium glaucum, Fr.
*Cladosporium	Cladosporium roesleri, Catt.
Tufted Vine-blight	Cercospora viticola (Sacc.)
*Vine Alternaria	Alternaria vitis, Cav.
Fumagine	Fumago vagans, Pers.
*Vine Fusarium	Fusarium viticolum, Thuem.
*Vine Strumella	Strumella vitis, McAlp.
*Brown Leaf-spot	Phyllosticta vitis, Sacc.
*Squirt Berry	Phoma tuberculata, McAlp.
*Nipple-like Cytospora	Cytospora mammosa, McAlp.
*Slender-stalked Hendersonia	Hendersonia tenuipes, McAlp.
Anthracnose or Black Spot	Sphaceloma ampelinum, D. By. Glœosporium ampelophagum (Sacc.) Phoma ampelina, B. and C.
*Coloured Glœosporium	Glœosporium bicolor, McAlp.
Pestiferous Glœosporium	Glœosporium pestiferum, Cooke and Mass.
Grape Pestalozzia	Pestalozzia uvicola, Speg.
Brown Rot or Downy Mildew	Plasmopara viticola (Berl. and De Ton.) Peronospora viticola, B. and C.
*Pourridié or Mouldy Rot	

Saprophytes.

*Vine Psathyrella	Psathyrella ampelina, Foëx and Viala Fibrillaria xylothrica, Pers.
Branch-loving Didymella	Didymella cladophila (Sacc.)
*Gregarious Catharinia	Catharinia gregaria, McAlp.
*Olivaceous Pleospora	Pleospora olivacea, McAlp.
*Cook's Aspergillus	Aspergillus Cookei (Sacc.)
*Black Sterigmatocystis	Sterigmatocystis nigra, V. Tiegh.
*Two-coloured Penicillium	Penicillium bicolor, Fr.
Lesser Cladosporium	Cladosporium asteroma, var. minor Cooke
*Grape Cladosporium	Cladosporium uvarum, McAlp.
*Velvety Macrosporium	Macrosporium velutinum, McAlp.
Isariopsis	Isariopsis clavispora (Sacc.)
Short-spored Chaetomella	Chaetomella brachyspora, Sacc. and Speg.
Sessile Robillarda	Robillarda sessilis, Sacc.
*Bark Hendersonia	Hendersonia sarmentorum, West.

1. AUREO GRAPE-ROT.

(Aureobasidium vitis, var. tuberculatum. McAlp.)

History in Europe.—The genus *Aureobasidium* was constituted by Viala and Boyer for a fungus found injuring the grapes (Frankenthaler and Chasselas) in the south of France in 1882, and consists of a solitary species *A. vitis.* In this species a thick yellow layer is formed which ruptures the epidermis and bears the clear yellow conidia on sterigmata, generally 6 or from 4 to 2. The conidia have an average size of 6 × $1\frac{1}{2}$ μ[1]. In 1894 it was found on the leaves, causing them gradually to lose their green colour and become red, thus giving it the name of the "red disease."

In January of this year, Dr. Montemartini, of the Cryptogamic Laboratory of the University of Pavia, published a paper on "A new micro-fungus of the Vine," which he named *A. vitis*, var. *album*, because the pustules were whitish. It occurred on the leaves and fruit-stalks of vines growing at Trieste, and the following is the diagnosis :—Pustules sometimes confluent ; whitish ; basidia hyaline, 6–7 μ broad (on upper portion), 13–22 μ long ; spores cylindrical, 6–8 × 1·5–2 μ.

History in Victoria.—For some years past the Champion Muscat has been affected with some unknown disease, not only in different districts of Victoria, but also in New South Wales and South Australia. This disease attacks the berries, and although the grapes set well and come to partial maturity, yet at that stage the fungus attacks the best of them and ruins the crop. As one grower informed me, he expected 40 cases from the grapes when they were formed, but did not realize even one case. This happened at Mr. Gow's Abbotshall Vineyard, Rutherglen, and, notwithstanding that the season (1895–6) was exceptionally dry and suited the vines in that district, the Champion Muscats were a comparative failure, while the other varieties yielded a splendid crop.

Mr. Thiele, of Doncaster, also informed me that his Champion Muscats were badly diseased, and on visiting his place on 28th March, 1896, I found that many of the berries were shrivelled up, and others, although still soft, were discoloured in patches. The vines on either side of the Champion Muscats bore large and healthy crops, and it was evident that the latter were specially liable to this destructive disease. On a microscopic examination of specimens the disease was found to be due to what then seemed to be a species of *Tubercularia.*

Mr. G. H. Robinson, of Ardmona, had likewise observed various diseases on grapes, and one of them turned out to be the same as that on the Champion Muscat. This disease was first observed by him in February, 1895. In April, 1896, the tubercles were found in abundance and along with them undoubted specimens of *Aureobasidium*, but no direct connexion was then established. It was just a year later (April, 1897), when Mr. Robinson was examining some berries differing slightly from the ordinary *Aureobasidium* in possessing a greenish appearance that he discovered a greenish tubercle at the base of the ordinary *Aureobasidium* filaments, and established the important fact that *Aureobasidium* may occur either with or without a tubercular base. The tubercular form was now proved to be simply a stage of

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[1] μ = micro-millimetre or micron = $\frac{1}{25000}$ inch.

Aureobasidium, and so the hitherto unknown cause of the disease turned out to be *A. vitis.* var. *tuberculatum* (see Fig. 1). The same fungus was found on grapes grown at Great Western and Dookie as well, so that it is probably widely distributed in Victoria.

Varieties Affected.—Although the Champion Muscat is so generally affected, the disease is not by any means confined to it. In the Goulburn Valley it is the Gordo Blanco and Black Prince which suffer most, and in a lesser degree the Raisin des Dames, Doradillo, Snow's Muscat and the Verdeilho.

Parts Affected.—The fungus has only been found here on berries and fruit-stalks, but in Europe, as already remarked, it occurs upon the leaf, causing it to change colour and become red. While this reddening of the leaf was not a characteristic feature at Ardmona, it was very marked on the Dookie specimens. Through the kindness of G. Briosi, of the Botanic Institute University of Pavia, I had a specimen of leaf affected with a variety of *Aureobasidium* from vines growing at Trieste, and while it closely resembled the Dookie affected leaves, still I was unable to detect any trace of the fungus on the latter.

Injurious Effects.—In certain parts of the colony during the last two years it has done more harm than any other disease, particularly to the grower of table grapes. The dryness of the seasons was certainly unfavorable to the development of disease generally, but the Aureo Grape-rot seemed to thrive even under such adverse conditions. It renders the fruit soft and worthless for market.

Common Name.—At one stage it is a white rot, at another brownish or greenish, so that it is difficult to get a characteristic common name for it. Under the circumstances I have adopted a contracted form of the scientific name, "Aureo Grape-rot." Among some of the leading vignerons there is a very general impression that the disease known as "White Rot," due to a fungus scientifically called *Charrinia diplodiella*, is present in Australia ; but since that fungus has not yet been found here, I am inclined to think that the whitish appearance of the disease caused by *Aureobasidium* is mistaken for it.

External Characters.—Berries usually shrivelled and sometimes very much depressed, soft, with whitish or brownish—sometimes greenish—patches underneath skin. The apparently discoloured cuticle is usually partly raised, unbroken, and always easily lifted. Not infrequently the berries are found studded with very minute greenish dots and very slightly shrivelled towards the end of the grape season.

Microscopic Characters.—The fungus occurs either with or without a tubercular base.

Mycelium composed of delicate colourless hyphæ, septate, much branched and spreading, with granular contents, average 2 μ broad.

Fertile hyphæ colourless, flexuous, septate, branched, composed of rows of cells, often irregular in thickness and highly vacuolated, $5\frac{1}{2}$–11 μ wide, and forming a somewhat compact layer.

Basidia are either terminal or lateral, slightly swollen, average length 13–15 μ, and breadth 4–$7\frac{1}{2}$ μ, giving off radially several conidia (up to seven) at the ends of minute sterigmata, which appear like little clear points even under a high magnifying power ; the ordinary end of a filament occasionally functions as a basidium.

Conidia hyaline, oval to cylindrical, rounded at both ends, but slightly tapering towards attached end, with granular or turbid contents 7–17 × 1½–4 μ, average 9–10 × 3 μ. While still attached and probably immature, a common average is 6–9 × 1½ μ. Tubercles at first colourless, then becoming greenish to greenish-brown, gradually extending from base upwards, and attaining a height of about ½ mm., or occasionally a little more. Sometimes they appear to differentiate from a continuous mass ; at other times, later in the season, they are quite distinct from the first. They consist of septate, branched, greenish filaments, composed of variously shaped cells, cylindrical, oval, or cuboid, and frequently tapering towards the free end into slender, sinuous, hyaline filaments, ranging in size from 22 μ broad to 1½–2 μ.

Microspores spherical, faintly tinged with green, produced at the free end of filaments, 4½ – 5½ μ diameter.

Macrospores spherical to sub-spherical or slightly polygonal, colourless or pale yellow, with smooth firm wall and granular contents, either produced terminally or intercalary. The colourless spores are spherical, and average 19–23 μ diameter, while the pale-yellow spores are less regular in shape, and 11–14 μ diameter. Both occur together.

Occurrence, &c.—On ripe grapes and on fruit stalks. January—May, 1896–7. Doncaster, Great Western, and Dookie. (Ardmona, Robinson, 155.)

Remarks.—This fungus was found on grapes growing at Doncaster, also on grapes sent to me from the Great Western as being affected with the "Noble Rot," but no trace of that fungus was found. It was likewise met with at Dookie and in the Goulburn Valley, and is probably common elsewhere.

The sterigmata are very minute, but with judicious pressure the conidia can be seen swinging about on them without becoming detached. In the specimens from Dookie the conidia were ovoid or oval, and much broader than ordinary, but otherwise the fungus was the same (see Fig. 6).

Some Black Prince Grapes, bought in the suburbs of Melbourne towards the end of May, were badly affected with this disease. They were of a reddish-purple colour, soft and moist, and with depressions, as if made with the tip of the finger. In these indentations, where the skin is crinkled and slightly dotted on the surface, there is abundance of *Aureobasidium* producing conidia at all stages of development.

The berry may sometimes blacken, due to the presence of other fungi associated with it, such as species of *Cladosporium Macrosporium*, &c.

While this species closely resembles *A. vitis*, still there are distinctions which seem to me at least varietal. These differences may be tabulated as follows :—

A. vitis, var. tuberculatum, McAlp.	A. vitis, Viala and Boyer.
1. Whitish or brownish discolouration of berry.	Light yellow colour.
2. Pustules not erumpent generally.	Pustules erumpent.
3. Spores hyaline, straight, 9 × 3.	Spores light-yellow, slightly curved, 6 × 1½ μ.
4. Tubercular base frequently.	Tubercle absent.

A notice on "L'Aureobasidium en Australie" in the *Revue de Viticulture* of 12th December, 1896, by Professor Viala, may fitly close this description—"We have quite recently recorded with G. Foëx the presence of *Aureobasidium vitis* in Russia, the leaves sent to us by B. Tairoff came from the Crimea and not from Bessarabie. We have reported that the fungus, very virulent upon the leaves, had caused considerable damage. D. McAlpine informs us of the development of an *Aureobasidium* in Australia, which from the drawings and description sent to us appears to be identical with the species which we have, along with G. Boyer, noted and described for the first time in France. This *Aureobasidium* has been found abundantly in the Victorian vineyards, where it was common upon the ripe berries, and caused great damage in the rotting of the fruit. We will return to the important work which he is going to publish upon the fungi parasitic on the vine in Australia."

Reproductive Bodies.—Several distinct reproductive bodies are produced, but in the absence of cultures and germinating tests, it is impossible to say what becomes of them. At least three distinct kinds were met with. 1. The normal reproductive bodies are the *Conidia*, produced on the swollen ends of filaments or laterally, arranged radially even up to seven on one basidium, and attached by sterigmata. The conidia-bearing filaments might either spring from a tubercular base or not. The conidia are usually produced during March, April, and May. The other two kinds are derived from the tubercles, and since one is relatively much smaller than the other, I have provisionally named them microspores and macropores. 2. Minute, spherical *Microspores*, colourless or with the slightest tinge of green, produced at the free ends of the filaments and detached. 3. Relatively larger, spherical or sub-spherical *Macrospores*, colourless to pale yellow, and produced either terminally or intercalary.

Comparison of Specimens from Different Districts.—There were slight variations in specimens obtained from different districts of Victoria worthy of note. Specimens from Doncaster (10 miles from Melbourne) examined in March, 1896, showed tubercles producing conidia. These tubercles were somewhat distinct or run together, only moderately elevated, and of a pale-green colour, but more or less colourless towards exterior. The epidermis was raised and partially ruptured, and there were no conidia-bearing filaments projecting. The basidia when carefully examined were seen to be of a golden-yellow colour.

Specimens from Great Western (168 miles north-west of Melbourne) examined in April, 1896, showed a golden-yellow stroma forming a more or less continuous tubercular layer about 75 μ high, distinctly rupturing the epidermis and bearing conidia.

Specimens from Ardmona (about 110 miles north of Melbourne) examined in April, 1897, showed pale olive-green tubercles with long hyaline filaments proceeding therefrom, and bearing numerous gonidia. The epidermis was not ruptured, only raised, in the great majority of cases.

Stages of Tubercle.—From the examination of a great variety of gradations from different districts, the tubercles appear to pass through the following phases. They may, first of all, produce radiating conidia either directly or indirectly at the end of long filaments proceeding from the tubercular base. Then after the production of abundant conidia, they may increase in size and become more condensed or the tubercular base may gradually encroach upon the colourless filament until the whole becomes a condensed and coloured tubercle. The tubercle may now produce either micro- or macro-spores before passing into winter quarters, but the further fate of it has not been followed.

Classification.—The systematic position of this fungus has not been definitely settled. Viala and Boyer assign it to the *Hypochnaceæ*, while Saccardo considers it to belong to the *Thelephoraceæ*. Montemartini, on the other hand, regards it as related to the *Tuberculariaceæ* among the Hyphomycetes, and probably an intermediate and possibly autonomous group between the Basidiomycetes and the Hyphomycetes. This latter view is strongly supported by the Australian form, which has much in common with the variety determined by Montemartini. (Figs. 1–12.)

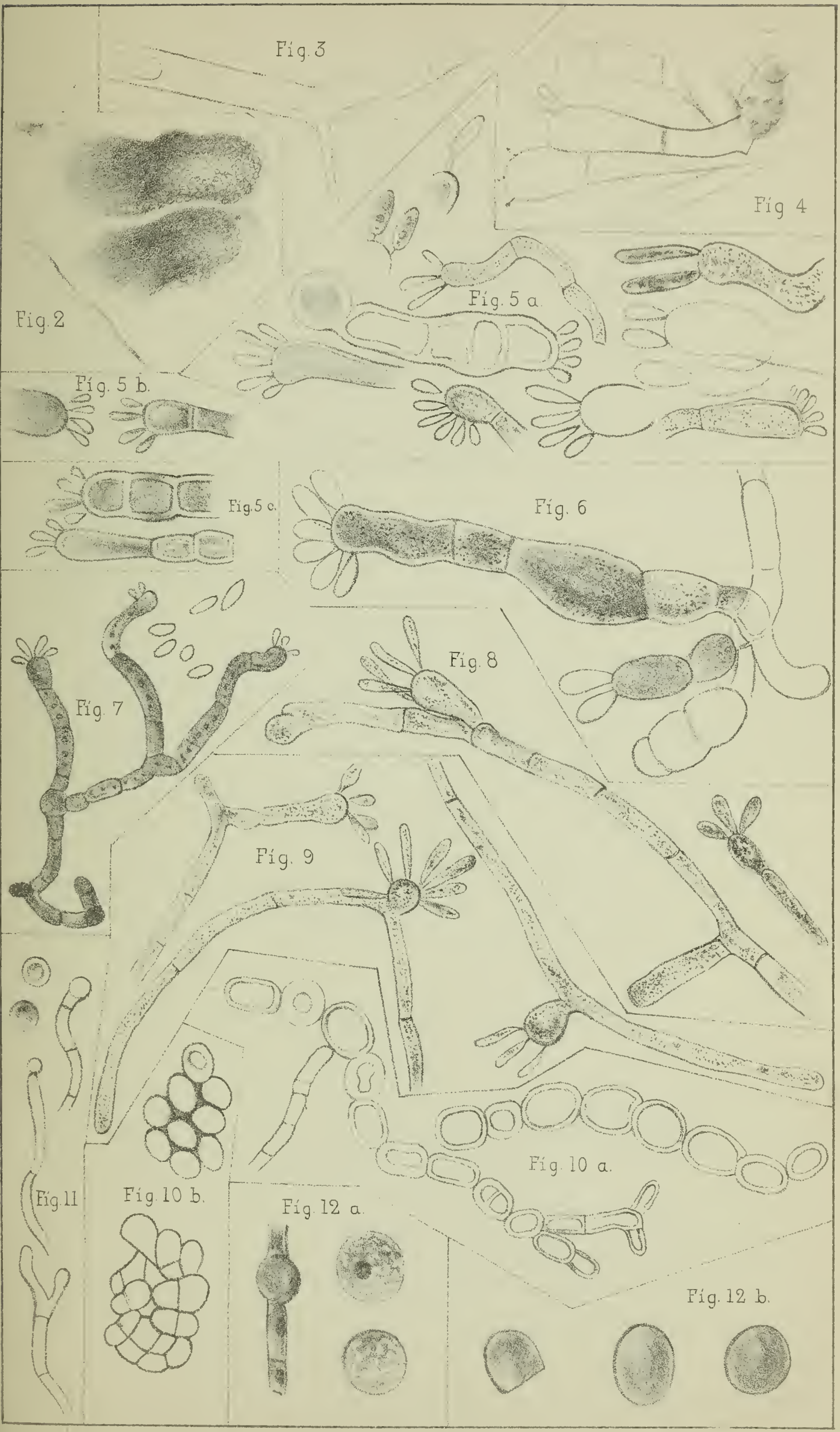
PLATE III.

AUREO GRAPE-ROT (AUREOBASIDIUM VITIS, VAR. TUBERCULATUM).

Fig.

1. (See Plate I.)
2. Patch of two elongated greenish-brown tubercles at base, continued into a dense mass of fine filaments partially green. Sometimes the colour extends from base to summit, and the entire mass is then tubercular (× 52).
3. Branching hypha (× 1,000).
4. Hyphæ ending in basidia and showing sterigmata (× 1,000).
5. Basidia with attached conidia at various stages of development, *a*, Ardmona specimens, *b*, Doncaster specimens, *c*, Great Western specimens (× 1,000).
6. Fertile hyphæ with stout conidia. Dookie specimen (× 1,000).
7. Twisted and branching fertile hyphæ, also conidia detached (× 550).
8. Conidia produced on basidia laterally as well as terminally (× 550).
9. Lateral swellings bearing conidia (× 1,000).
10. Hyphæ of tubercle, showing variously shaped cells, sometimes becoming pseudo-parenchymatous (*a*, × 325, *b*, × 600).
11. Microspores at free end of filaments and detached (× 1,000).
12. Macrospores—*a*, colourless and showing intercalary formation (× 550), *b*, coloured pale yellow (× 1,000).

PLATE 3.



D.McA del.

UNIVERSITY OF ILLINOIS.

2. SQUIRT BERRY.

(*Phoma tuberculata. McAlp.*)

History and Symptoms.—This disease was observed for the first time by Mr. Robinson, in the Ardmona district, during February, 1895, and has been continuously under observation since. The skin of the affected grapes is extremely moist and soft, and the slightest pressure causes them to burst, hence such grapes prove very troublesome in picking and packing. It is rather a serious disease not only from the actual loss of the berries affected, but also from the damage done to others by keeping a lot of moisture constantly around them, and thus spoiling a large proportion of otherwise healthy berries.

Common Name.—Owing to the soft squashy nature of the affected berries the common names given to this disease in the Ardmona district are " Soft Rot " and " Squirt Berry." " Soft Rot " is too generally applicable to various diseases to be specially descriptive of this one, but as the berries when gently pressed between finger and thumb readily squirt out their contents, the latter term has been retained as the common name,

Conditions of Development.—It would appear that this fungus requires for its favorable development fairly frequent rains when the grapes begin to ripen and afterwards throughout the season. This is supported by the results of observations made both at the time of its first appearance and since. The atmospheric conditions prevailing during the season of its first appearance are thus described by Mr. Robinson—" The spring and summer had been very dry, until the end of January hardly any rain fell, but in February and the early part of March more than the average was experienced, accompanied by muggy weather, while afterwards there were frequent showers with heavy dews at night. Until the rain in February there was hardly a trace of the disease, but since then it spread rapidly through the different vineyards, inflicting in some cases severe loss on the growers of table grapes. A few diseased berries in a bunch are sufficient to wet a whole basket of grapes during picking, and as grapes cannot be marketed in this condition, some idea of the troublesome nature of the disease may be formed."

During the season just past, less rain fell when the grapes were ripening, and the amount of damage done by the fungus was considerably less than in the previous season.

Varieties Affected.—The Gordo Blanco is the most susceptible, followed by the Raisin des Dames, then the Doradillo, Black Prince, Ladies' Fingers, Red Malaga, and Wortley Hall. It will be observed that either tough or tender skinned grapes are affected.

External Characters.—Berries attacked show at first a circular patch from ashy grey to slaty blue in colour, dotted and speckled with very numerous gregarious and confluent tubercles or pustules, for a long time covered by epidermis. The affected surface usually occupies about a third of the grape, sometimes almost the whole, and is somewhat rough in appearance. Towards the end of the season the berries dry partially, but are all pliable.

Microscopic Characters.—Hyphæ in underlying tissue colourless, septate, intricately branched, from 2 to 4 or 5 μ in diameter, thin branches passing into thicker. Hyphæ immediately beneath cuticle at first colourless, then greenish or brownish from $2\frac{1}{2}$–$4\frac{1}{2}$ μ in diameter, and either intricately branched or coalescing to form a more or less elongated columnar or sometimes globular pseudo-parenchymatous mass, composed of polygonal cells, sometimes attaining a height of over 400 μ. The tubercles may produce other reproductive bodies, but ultimately give rise to perithecia in various ways. The epidermis is raised by the elongating tubercle and finally ruptured, but until then it is firmly secured by strands of hyphæ.

Perithecia spherical to oval, confluent, with dark-brown walls apparently black and yellowish towards interior, either sessile or raised on tubercles when one may be at free end, or two alongside each other at either base or apex, or one above the other, or only one at the base. When one or two are situate at the base, the tubercle is continued beyond the perithecium, and the whole structure somewhat resembles a squat bottle ; perithecia 110–150 μ in diameter.

Sporules hyaline, oblong or oval, with granular contents or guttules, 6–8 × 3–$3\frac{1}{2}$ μ, borne on slender basidia.

Microspores.—In what appears to be an early form of the tubercle, there is to be seen a mass of colourless spores lying on the ruptured cuticle along with various substances, chiefly sugar. At this stage the grape is excessively soft and moist. These spores originate from the exterior of the tubercle, are thin-walled and very variable in shape and size, the most common form being oval to elongated pear shape, 6–9 x 2–3 μ.

Macrospores or Resting-spores.—The tubercles have also the power, according to conditions, either at an earlier colourless stage or at a later brown stage to detach thick-walled terminal cells as reproductive bodies. The colourless, spherical, or subspherical thick-walled cells with granular contents are met with of different sizes, but they may reach a diameter of 11–13 μ.

The brown thick-walled cells are also of various sizes, but may reach a diameter of 22 μ when mature.

Occurrence, &c. — On ripe grapes. Ardmona, February–May, 1895–6–7. (Robinson, 147.)

Reproductive Bodies.—The typical mode of reproduction is by *sporules*, but the tubercles also directly produce spores of various kinds at their exterior. The relatively small ones, provisionally named *Microspores*, are produced in a Glœosporium-like fashion. The larger thick-walled forms, which probably act as Resting-spores, may be called *Macrospores*, and are produced at a more advanced stage of the tubercle. The tubercle at this stage may be seen bursting through the epidermis, and various graduations may be traced. In the same section may be met with colourless to pale-greenish tubercles, breaking up into similarly coloured spores at their free margin, or more advanced tubercles forming a dense dark-brown rind of polygonal thick-walled cells, while the interior may be colourless or partially transformed into brown thick-walled cells smaller than those of the rind. There are thus, at least, three different kinds of reproductive bobies—Sporules, Microspores, and Macrospores, and the two latter, produced from the exterior of the tubercle, are seen to be of a different character to those belong-to the tubercle of *Aureobasidium.*

Comparison with " *Black Rot* " *and* " *White Rot.*"—The fungus just described differs from any known to me recorded on the vine, but as there were certain features of it suggestive of " Black Rot," and since that disease has already been determined for Victoria by Mr. Massee, of the Royal Gardens, Kew, I have thought it advisable to make a comparison between the two. Mr. Massee, in *Grevillea* for September, 1893, thus writes—" Unfortunately this disease, known in the United States as ' Black Rot,' has been found on grapes from Victoria, but the ascigerous condition has not been detected in Australia." I have been unable to trace the district from which these diseased grapes were sent, and there is no specimen in the National Herbarium. It is strange that none should have come under my own direct observation, either from specimens sent or vineyards inspected.

I am indebted to Mr. Luehmann, F.L.S., Curator of the National Herbarium, for an American specimen of " Black Rot " (*Phoma uvicola*, B.C.), from which sections were made, and a sporule is given for comparison (Fig. 18).

The " Squirt Berry " disease, as found in Victoria, differs in several important respects from the ordinary " Black Rot " of America. In the first place its general appearance is not suggestive of " Black Rot," for instead of the berries being hard, dry, and black, they are soft and moist, and range from an ashy grey to a bluish slate colour. The surface of the berry, either in whole or in part, is covered with greyish blister-like minute swellings, with an agate-like arrangement, and these afterwards become darker in colour, even quite black. The surface thus appears crinkled and speckled, and depressed areas are also formed with prominent ridges, but these do not stand out like projecting ribs as in " Black Rot." I was struck in reading Professor Viala's masterly description of the " Black Rot " with a reference to somewhat similar symptoms to those here described. He says—" But the affected berries continue to alter in the warm and humid regions of the United States, even to complete maturity, and present rather peculiar characters. The grapes do not wither and dry up as usual ; they become juicy and moist, even for Labruscas. The tender skin is of an inky black, deeper in colour than that of the grains altered before the period of maturation. These fruits rot without becoming shrivelled, and the skin is studded over with innumerable small pustules in contact." However, in the present disease there is no such blackening of the berry, while the softening is a constant feature even in the driest seasons.

Secondly, the presence of a tubercular or sclerotioid structure, ultimately bearing perithecia, is a characteristic feature of this disease. Sometimes it is of considerable size and height ($\frac{1}{4}$ mm.), sometimes so reduced that the perithecium appears to be sessile, still it is always there more or less. Now there is no record of any such tubercular structures bearing the perithecia in " Black Rot," and it is to be presumed that they do not exist.

Thirdly, the perithecia are not only borne aloft on tubercles, but there may be two alongside of each other or one on top of the other, and no pore has been observed, although that might be due to immaturity.

Finally, no sucker-like bodies have been observed upon the hyphæ as in the case of "Black Rot," and altogether the nature of the fungus and the external symptoms preclude the idea of this dreaded disease.

There is another disease of American origin which was long confounded with the "Black Rot," and is said to occur in our vineyards, viz., "White Rot." In this disease the berries assume a livid colour, become soft, rotten, and wrinkled, and the greyish or sometimes brownish pustules are scattered all over the surface. But the perithecia are not borne on tubercles, and the mature sporules are dark-brown, so that here again the distinction is clear.

The spores of "Black Spot" or "Anthracnose" also resemble these in size and shape, being colourless, ellipsoid, and $7–9 \times 3–4\ \mu$, but they are produced in a totally different way and the external symptoms are quite distinct. (Figs. 13–14.)

PLATE IV.

"SQUIRT BERRY" (PHOMA TUBERCULATA).

Fig.
13. Transverse section of healthy skin of grape—outer surface (× 325).
14. (See Plate I.)
15. (See Plate I.)
16. Outlines of perithecia in longitudinal section (× 145).
17. Sporules, showing one to right still attached to basidium (× 1,000).
18. Sporule of "Black Rot" for comparison (× 1,000).
19. Sporules of "Anthracnose" or "Black Spot" for comparison (× 1,000).
20. Hypha projecting from tubercle, showing terminal cell, brown and thick walled; others colourless (× 1,000).
21. Colourless Microspores, produced at exterior of tubercle (× 1,000).
22. Colourless Macrospores, produced at exterior of tubercle (× 1,000).
23. Brown Macrospores, produced at exterior of tubercle (× 1,000).
24. Portion of thick-walled dark-brown rind, with projecting cell (× 1,000).

PLATE 4

Fig. 13

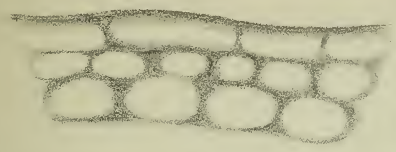
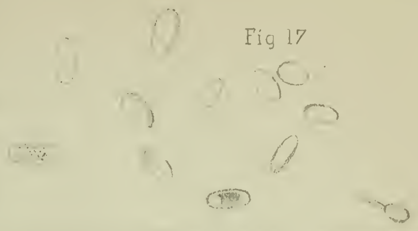


Fig 17



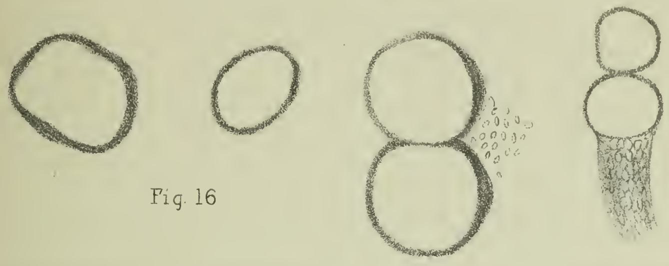


Fig. 16

Fig. 18

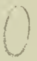


Fig. 19

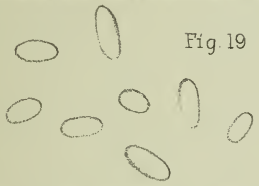


Fig. 20

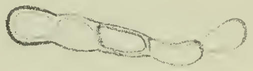
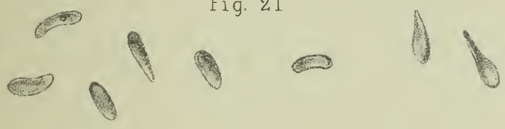


Fig. 21



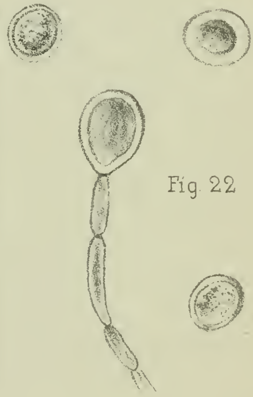


Fig. 22

Fig. 23

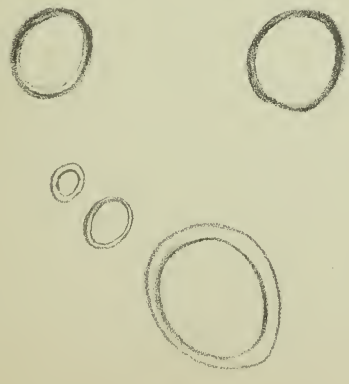
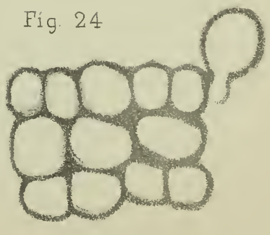


Fig. 24



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3. SWEET ROT OR NOBLE ROT.

(*Botrytis cinerea. Pers.*)

History in Victoria.—This fungus was first observed by Mr. Robinson, at Ardmona, in 1894, doing considerable damage to the vines owing to heavy and continuous rains just before Easter, but probably it has been with us much longer, although unobserved. During the past season a fair amount of *Botrytis* was met with on berries lying upon moist ground up to the second week in February, but no perceptible damage was done, on account of the dryness of the season. It was very prevalent during the previous season from February even till July, when it was still met with on bunches of grapes lying on the ground. It is easily recognised, since it covers the berries with a dense coating of a smoky-grey or greyish-brown colour, which may even extend to entire bunches, and cause the whole mass to rot. This damp rot is favoured by warm moist weather, and was specially observed on the Gordo Blanco. The Gordo Blanco is more extensively grown at Ardmona than any other, excepting possibly one or two varieties of purely wine grapes. This variety has a tender skin, which is very liable to crack in moist weather, thus giving the fungus a good start, after which it spreads with such rapidity that in two or three days branches which were perfectly healthy may become one festering mass of disease. Other varieties, with a tough skin, such as the Doradillo, which consequently do not split so readily and offer greater resistance to the entrance of the germ tube, are far less subject to attack. It also attacks the stalk, causing the grapes to fall, and if it infects the part just beneath this, the end of the bunch is not nourished, and the grapes there are dry and green.

History in Europe.—It is very common in European vineyards, and indeed wherever the vine is grown, and its history is a very instructive one. As far back as 1874 it was pointed out by Zimmerman that this fungus, which had long been known as occurring on dead vine leaves and regarded as a common saprophyte, was able to pass from rotting leaves on the ground to healthy leaves on the vine. And now it is common enough on the ripe berries, where it produces a special ferment, which prepares the way for the spread of the mycelium, and thus it does considerable damage in a short space of time. The rotting of the berries, therefore, is due not, as is often thought, to excessive moisture, but to a fungus like the Oidium and Downy Mildew. A delicate grey mould appears on the berries, and this is the cause of the decay, not the consequence, as many suppose. This is the fructification producing myriads of spores, whilst the vegetative portion of the fungus, or mycelium, is inside the berry.

"*Noble Rot.*"—Not only is this fungus remarkable for changing its habits so far as to prey upon living as well upon decaying vegetable matter, but it has the reputation of improving the quality of the wine made from berries attacked by it. It is found that the mycelium of this fungus lives upon the sugar, acids, and soluble nitrogenous substances of the grapes, so that the juices are rendered less acid and more concentrated owing to the evaporation of water from the injured surface. Hence it is the custom in some districts of the Rhine and elsewhere to leave the bunches of grapes hanging until December, when this fungus is upon them, and such diseased grapes are found to yield the best and sweetest wines. It has, therefore, received the names of *Edelfaule* and *Pourriture noble*, and may be called in English, from its effects, the "Sweet Rot." It has even been suggested that this fungus might be used for the same purpose in Victoria, but the injury caused by it in our favoured climate would hardly be counterbalanced by the possible benefit to vine-growers when compared with the very serious losses that have already been sustained by the growers of table grapes. Besides, in the majority of the wine-growing districts of Victoria, the percentage of sugar in the must is usually, if anything, excessive, so that our vignerons are not likely to regard this parasite with favour. According to recent researches it is extremely probable that the presence of Botrytis on grapes increases the amount of glycerine in the wine.

Professor J. Dufour, writing in the *Chronique Agricole* of 25th November, 1896, has some very pertinent remarks on this subject. After referring to a visit to the famous vineyard of Sauterne in the Gironde towards the end of September, when he asked a vigneron what he thought of the harvest, and was told that it would not be good as *the grape did not rot well*, he says—"One wishes to know why the same fungus produces the 'Noble Rot' at one time, and at another, and much more frequently, the injurious rot. Evidently that is due to various causes. In districts where autumn is habitually dry, the 'Noble Rot' is produced more easily, especially where the vineyards are on sunny hill sides. In low damp situations, the injurious form of rot will appear, even on the Rhine. The nature of the vine also exercises a great influence. The Riesling of Johannisberg or 'Petit Rhin' has small thick-skinned berries, which thus resist more easily the disorganizing action of the fungus. In Chasselas, the skin is not sufficiently thick to allow of the development of the 'Noble Rot'; the berry is delicate, and the thin skin is too rapidly destroyed by the parasite."

In a word, the nature of the vine itself, as well as the soil and climate, heat and moisture, influence the result, and with us there are no severe winters to check the too luxuriant development and consequently injurious action of this fungus.

Injurious Effects.—Not only does this parasite cause rust-coloured spots on the leave of the vine, but also considerable mortality among American seedlings, and in the south of France, where the cultivated varieties of the vine were grafted on to American resistant stocks, this fungus appeared and prevented their union. It also secretes an oxidizing diastase which acts upon the colouring substance of the wine and causes what is known as trouble or "casse" of wine. It likewise causes stem-rot of potatoes, dry and wet rot of the tobacco leaf, the decay of various seedlings, and the death of many plants through appearing on the roots. Hence the risk is too great to encourage its spread in any way whatever.

It is hoped that the following description will render its recognition easy, for I find that mistakes are sometimes made concerning it. In April, 1895, I received from Professor M. Blunno, of Great Western, specimens carefully packed, accompanied by the following note:—"I send you a specimen of grape affected by the *Noble Rot*, that is called in Italy 'Uva infavata.' As it is the first stage of the *Botrytis acinorum*, you cannot find the appearance gonidiophora of Botrytis which happens when the grapes are left on the vines after its industrial ripeness, if the conditions of the surrounding air are favorable." As a matter of fact, I found the *Aureobasidium*, but no *Botrytis*.

Treatment.—Recognising that this particular grape-rot is due to a definite fungus, which attacks various parts of the vine, first producing its vegetative portion or mycelium inside, and then appearing on the outside in the form of a fructification, it is evident that such measures should be employed as will either remove the cause or mitigate its effects. To this end several suggestions may be made.

1. Drainage should be attended to, since the liability to this disease is greatly increased by cold and damp soils.

2. As the grape-rot only appears when the berries are ripening, treatment should be undertaken before that. Both powders and liquids have been tried, but without giving very decided results. The Bordeaux Mixture applied for other diseases, such as Oidium, would probably have a beneficial effect also on this.

3. Since the fungus may winter on the fallen leaves and other portions of the vines, all refuse of the vineyard should be burnt as far as practicable, and even the spraying of the soil, as well as of the vine, should be resorted to.

External Appearance.—Covering entire surface of berries, and even whole bunches with ashy-grey or olive-grey tufts, usually confluent.

Microscopic Characters.—Sterile hyphæ, creeping, slender, sparingly septate, branched, hyaline, very evanescent.

Fertile hyphæ erect, gregarious, branched, shining, with several short simple or divided branchlets near apex, ultimate branchlets spinulose or with scattered rough projections bearing conidia, or conidia simply borne in hollows or on sides of cell-wall ; septate, not constricted at zepta or occasionally very slightly, smoky-grey, pale-green, or colourless, relatively thick-walled, somewhat flattened, with finely granular cohesive contents, 11–17 μ broad.

Conidia oval to globular-ovoid, yellowish in mass, greyish individually, thick-walled, turbid contents, 11–19 × 6–11 μ.

Occurrence, &c.—On ripe grapes. February–May. Ardmona. (Robinson, 152.) February. Near Melbourne.

Sclerotia and their Products.—This fungus is a good example of those which pass through several stages in order to complete their life-history, one of those stages being little hard black bodies, consisting of condensed hyphæ, and capable of withstanding the rigours of winter, extreme drought, wetness, &c. Such bodies from their hardness and firmness are known as *Sclerotia.* Towards the end of the season these bodies, wrinkled, irregularly knobbed, and 4-5th to 1½ inches in thickness occur on the berries, but most commonly on the fallen leaves. They may either produce a similar fungus to that from which they spring, as they were observed to do in Victoria (see Fig. 34) or in the ensuing spring they may give rise to an entirely different looking body, the so-called fruits, which are in the form of little cups mounted on a stalk. No wonder that they were regarded as distinct before the connexion was made out and named *Sclerotinia fuckeliana,* D. By., which is the highest and most developed stage of the fungus. At first every apparently distinct form was considered a separate species, and hence there were several *form-species,* each with its own special name. Thus the conidia-bearing stage was called *Botrytis cinerea,* the sclerotium stage, *Sclerotium echinatum,* and the cup stage, *Sclerotinia fuckeliana,* all phases in the life-history of the self-same fungus. (Figs. 25–34.)

PLATE V.

"SWEET ROT" OR "NOBLE ROT" (BOTRYTIS CINEREA).

Fig.

25. Branching top of fertile hypha (× 52).
26. Branching top (× 550).
27. Branchlets with conidia borne in hollows and on sides (× 270).
28. Pale-green fertile hypha branching towards base (× 270).
29. Portion of fertile hypha (× 1,000).
30. Hyaline granular contents projecting as a compact worm-like mass from broken fertile hypha (× 270).
31. Portion of creeping hypha, rather slender (× 1,000)
32. Detached conidia (× 1,000).
33. Germinating conidia (× 1,000).
34. See Plate II.

PLATE 5

Fig. 25

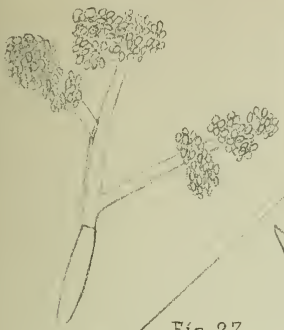


Fig. 26

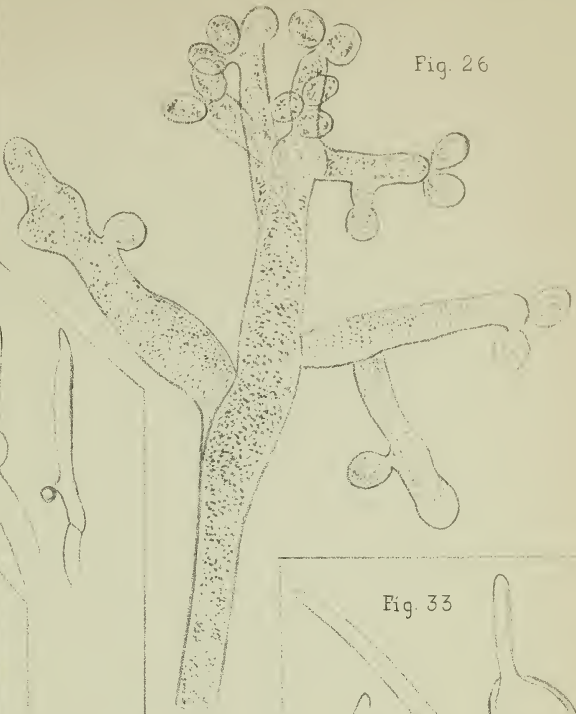


Fig. 27

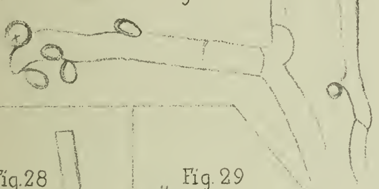


Fig. 28

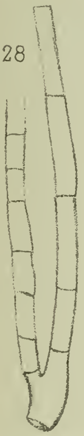


Fig. 29

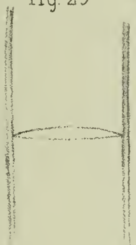


Fig. 30

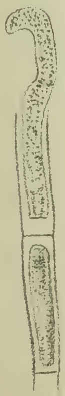


Fig. 31

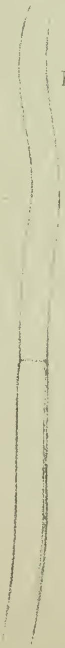


Fig. 32

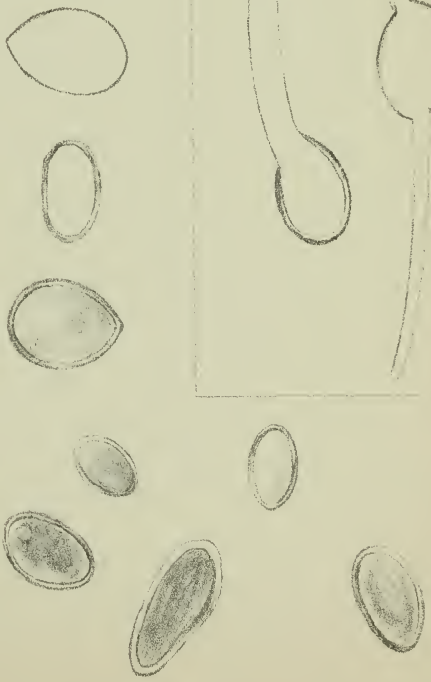
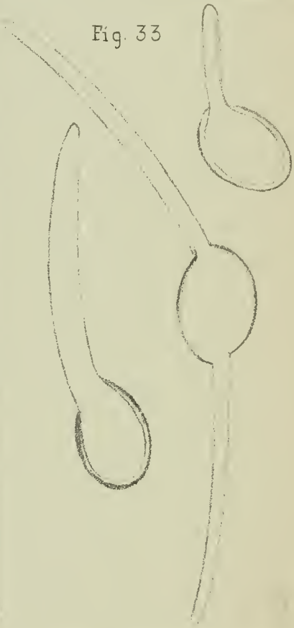


Fig. 33



D. McA. del.

4. POURRIDIÉ OR ROOT-ROT OF THE VINE.

General Description.—The roots of the vine are sometimes found to be covered with a white mould which I have heard called Oidium, but as we shall see it is quite a different fungus and quite distinct in its action. The disease occurs on vines growing in damp soil and commonly on newly cleared land. The cause of the disease is various, and has been traced to different fungi, but at present with us it has not been accurately determined for a very evident reason.

This at first white mould, which may change in colour, consists of innumerable delicate filaments or *hyphæ*, more or less interwoven or felted, which ramify and spread between the bark and the wood, and so ultimately cause the death of the vine. The unhealthy colour and the stunted and irregular growth are suggestive of the effects of phylloxera, and in some parts of France the fungus is quite as deadly as the insect. The filaments may spread in the soil, if the conditions are favourable, and thus start a fresh area of infection.

The fungus apparently may go on multiplying indefinitely in this way, but some time or other it will come to the surface and produce a fructification in the shape of a toadstool-like body. Thus we see that the matted filaments are simply the vegetative portion of the fungus, and it is only when the fructification is produced that the definite fungus causing the disease can be determined. Several distinct fungi have been determined in France, for instance, as the cause of this Root-rot, but hitherto there has been no such definite determination in Australia. Root-rot is not by any means confined to the vine, for I have found it on the roots of Eucalypts left in the soil after grubbing, on the root-like underground stems of the common bracken, as well as on the roots of various fruit trees, gooseberries, raspberries, &c. The Raspberry Root-rot has just been determined in Victoria as being due to a tufted Agaric known as *Hypholoma fasciculare*, and the Root-rot of the vine may be similarly caused. This Agaric is very common in Britain, and although long known there it has never been suspected of parasitic habits. It is stated to occur on stumps and dead roots, at the base of old trees and decaying gate-posts, but it was simply supposed to flourish on the decaying material and not to be itself the cause of it.

Treatment.—This is given at greater length in the Report on the Raspberry Root-fungus ("Guides to Growers," No. 32), but drainage and liming of the soil, together with removal and burning of diseased plants, are the principal measures to be relied on. The addition of salt to the lime in the proportion of two of lime to one of salt may be recommended.

5. VINE STRUMELLA.

(*Strumella vitis. McAlp.*)

External Characters.—Forming compact, black, warty tubercles, up to one-eighth inch diameter under certain circumstances, densely crowded in depressions of ripe berries.

Microscopic Characters.—Erumpent creeping hyphæ, hyaline, septate, branched, 2–4 μ broad, producing more or less upright, closely septate, densely crowded conidiophores, hyaline below, but towards tip becoming yellowish-brown, and usually expanding up to $4\frac{1}{2}$ μ broad. The denser, darker, outer portion forms a sort of rind to the pustule.

Conidia oval to elongated, dark-brown in mass, hyaline at first, but greenish-brown to brown when fully developed, variable in length, 6–16 × 4–5 μ.

Occurrence.—On ripe grapes. February–May. Ardmona. (Robinson, 148.)

Varieties Affected.—Cordo Blanco, Doradillo, Raisin des Dames, Ladies' Fingers, Black Saint Peter, Red Prince, Red Malaga, and Wortley Hall, nearly all the table varieties grown to any extent in the district.

The disease was also noted on Mataro and Carbinet wine grapes, these being the only two varieties which came under observation. It is probable that so far as wine making is concerned this fungus would prove comparatively harmless, whereas the growers of table grapes suffer considerably from it, as they do not pick the fruit immediately it is ripe, contrary to the practice of the wine-maker. The Gordo Blanco was by far the worst.

Remarks.—The warty, black, hemispherical pustules are very conspicuous, sometimes studding the berry in almost every part, either solitary or in dense clumps. They are seen at all stages, either just bursting through the skin and causing it to crack in a leech-bite fashion, or as irregular, rough, warty tubercles up to one-eighth inch across.

It was first met with in 1896 vintage, but during the past dry season it was practically absent from the vineyard.

I consider this fungus to belong to the series *Tuberculariæ dematiæ*, and to approach nearest to the genus *Strumella*.

There is a general resemblance to "Bitter Rot," caused by a fungus known as *Melanconium fuligineum*, Cav., or *Greeneria fuliginea*, Scribner and Viala, but the differences are sufficiently distinct to separate it. In the first place the affected berries are not bitter, whereas in the "Bitter Rot" they are particularly so. Then the conidia-bearing hyphæ are not distinctly branched towards the summit, but it is in the conidia themselves that the greatest differences consist. In the "Bitter Rot" they are described as ovoid or navicular, slightly contracted at the point of insertion, and somewhat acute at both ends, while here they are elongated, oval, and rounded at both ends. Besides it does not seem to belong to the *Melanconieæ*, since there is no indication of a pseudo-perithecium, and the conidia are not discharged through openings in the cuticle but freely on the surface of the tubercle. (Figs. 35–39.)

PLATE VI.

"Vine Strumella" (Strumella vitis).

Fig.

35. Shrivelled grapes (preserved in cork-dust for nine weeks) with tubercles (natural size).
36. Section of grape skin showing hemispherical pustules (× 145).
37. Showing pustule to right bursting through epidermis (× 145).
38. Terminal end of conidiophores (× 1,000).
39. Conidia detached (× 1,000).

PLATE 6

Fig. 35

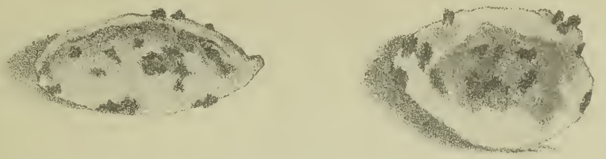


Fig. 36

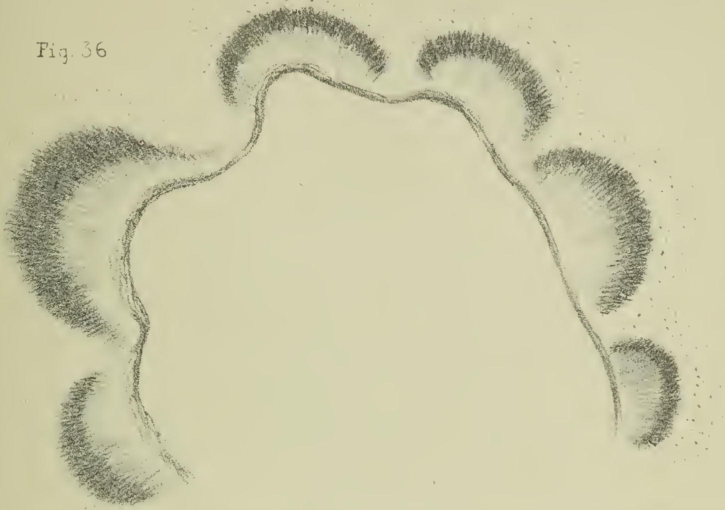


Fig. 37

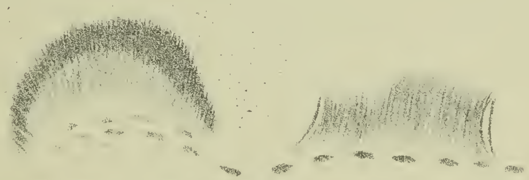


Fig. 38

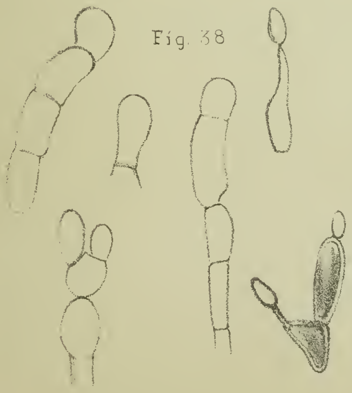
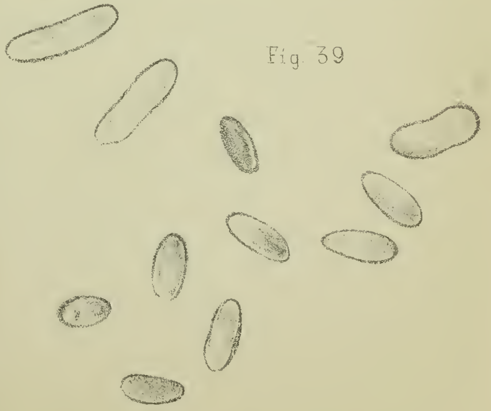


Fig. 39



D. McA. del.

6. "MOULDY ROT" OR "BLUE MOULD."

(Penicillium glaucum. Link.)

This bluish-green mould has already been proved to cause the rotting of apples, as detailed in "Guides to Growers" No. 30, and it is also known to cause the rotting of grapes. Wehmer has recently investigated this subject of rot in ripe fruit, and has found *P. glaucum* to occur most frequently in this connexion. While the "Sweet Rot" (*Botrytis cinerea*), as the common name denotes, leaves the juices less acid than before, the "Mouldy Rot" on the other hand leaves the juices more acid, absorbing the sugars in greater proportion than the acids. *P. glaucum* may occur on other parts of the vine as a saprophyte. On specimens from West Australia it occurred on the grape-stalks.

7. GLAUCOUS COREMIUM.

(*Coremium glaucum. Fr.*)

External Characters.—The attacked berries are quickly converted into a rotton mass of pulp. Just beneath the skin are several white balls, and if broken show green colour inside.

Microscopic Characters.—Hyphæ hyaline, septate, branched, coalesced into a dense ball, which opens up into a cup-shaped body, bearing the penicillately branched conidiophores.

Conidia sage-green in mass, hyaline individually, globose or subglobose, smooth, in chains, average 3–4 μ diameter, sometimes $5\frac{1}{2}$ μ.

Occurrence.—On grapes. April, 1897. Ardmona. (Robinson, 198.)

Remarks.—Beneath the cuticle a ball of colourless hyphæ is formed, at first white, but grey after being picked some days, and when crushed it is seen to be dark sage-green inside. Subsequently an opening appears in the ball at the surface adjoining the cuticle, and this gradually widens till the whole becomes cup-shaped. The cup-shaped portion is a deep sage-green from the mass of spores borne by the Penicillium.

In the usual Coremium-form the hyphæ are united so as to form a stalk-like structure, but here it is a Peziza-like body.

By some this is just reckoned a form of *Penicillium*, in which the conidiophores instead of being single are firmly united into a compact tuft; while others, like Saccardo, consider the compound structure of generic value, but the Peziza-like form has not hitherto been recorded. (Fig 40.)

8. ROESLER'S CLADOSPORIUM.

(*Cladosporium roesleri. Catt.*)

External Appearance.—Forming dark-olive effused layer on surface of berries, which become shrivelled and bluish.

Microscopic Characters.—Hyphæ pale greenish-yellow, rigid, septate, not constricted at septa, 3–$5\frac{1}{2}$ μ broad. Conidia produced in short chains of 2 or 3, coloured like hyphæ, variable in size, continuous or rarely uniseptate, spherical, oval, or ovate, finally cylindrical; smaller form 4–$8\frac{1}{2}$ × 4–$4\frac{1}{2}$ μ, larger form up to 39 × $6\frac{1}{2}$ μ. There are all intermediate stages, but the relatively smaller predominate.

Occurrence, &c.—On ripe grapes. February-May. Ardmona. (Robinson, 149.)

Remarks.—Not at all common, frequent rains and damp situations favour development. In Europe it has also been found on the under surface of living leaves, forming olive-green spots and causing considerable injury.

There is extreme variety in the shape and size of the conidia, varying from a spherical continuous form only 4 μ in diameter up to an elongated, cylindrical, sometimes uniseptate form 40 × 6–7 μ. In a chain the topmost is often colourless, being the youngest. (Figs. 41–43.)

9. COLOURED GLŒOSPORIUM.

(*Glœosporium bicolor.* *McAlp.*)

External Appearance.—Pustules at first of a yellowish-waxy colour, then becoming brown.

Microscopic Characters.—Pustules gregarious, sub-cuticular, erumpent, dark-brownish to dark-greenish towards base, gradually becoming yellowish-green near surface, then colourless towards free ends; sometimes the entire spore-bearing pustule may be colourless, over 300 μ high, composed of hyphæ which are firm, septate, and branched towards base, average 4 μ broad, more delicate towards free end, average 2–3 μ broad.

Hyphæ beneath pustule in the brown and dead tissue, hyaline, septate, branched, about 4 μ broad. Sporules minute, colourless, elongated, narrow, tapering to one or both ends, or somewhat navicular, occasionally uniseptate, 7½–11 × 2–3 μ.

Occurrence.—On ripe grapes of Raisin des Dames. March–May, 1897. Ardmona. (Robinson, 194.)

Remarks.—This has a general resemblance to Bitter Rot (*Greeneria fuliginea*, S. and V.), but there are several important differences—

1. The flavour of the attacked berries is not bitter.
2. The spores are perfectly colourless and they are narrower.
3. The pustules stand higher, over 300 μ.

The habit of this fungus is also different from that of Ripe Rot (*Glœosporium fructigenum*). The sporules are colourless even in mass, and they do not agree in shape. On rotting apples irregular salmon-coloured patches appear on the surface of the worst decayed parts, and sporules are given for comparison (Fig. 46). Until cross-infection is carried out, I prefer to retain this as a distinct species. (Figs. 44–46.)

10. FUMAGINE.

(*Fumago vagans.* *Pers.*)

General Appearance.—Forming a thin sooty layer on exfoliated bark of vine.

Microscopic Characters.—Sterile hyphæ creeping, vaguely branched, often confluent in pavement-like masses, torulose, smoky-brown.

Fertile hyphæ ascending, short, branched like a corymb, up to 10 μ broad.

Conidia at tips of branches in short chains, generally uniseptate, sometimes continuous or biseptate, coloured similar to the hyphæ and often just like a continuation, or sometimes a little paler, 6–15 × 4–7 μ.

Occurrence.—On exfoliated bark of vine. October, &c. Near Melbourne. Not hitherto recorded for Victoria.

Remarks.– This Fumagine is found on various plants and attacks all the organs of the vine, especially when in a young condition. It attacks the living parts and is therefore a parasite, interfering with the proper functions of the leaves and causing imperfect maturation. Adherent to table grapes, it renders them unsightly and gives to the wine a disagreeable taste. In the present instance it was evidently a saprophyte, and therefore I have placed it in that division.

It is generally regarded as the conidial condition of a Capnodium (*Capnodium salicinum*, Mont.). (Figs. 47–49).

11. VINE FUSARIUM.

(*Fusarium viticolum. Thuem.*)

General Appearance.—Tubercles numerous, sometimes confluent, erumpent, elevated on depressed portions of berry, smooth, gelatinous when moist. Colour at first very light pink, then deepening, frequently bright carmine when fully mature, later becoming coral-pink as the berries dry and shrivel.

Microscopic Characters.—Hyphæ densely fasciculate, septate, $2\frac{1}{2}$–3μ broad, tapering towards terminal end to 1μ broad.

Conidia fusiform, crescent-shaped or somewhat straight, colourless, generally 6–9 septate, not constricted at septa, and several of the joints usually with round lustrous spot, $36–49 \times 3–4\mu$.

Occurrence.—On ripe grapes. May–June. Ardmona. (Robinson, 165.)

Remarks.—This species was first discovered in July, 1876, by Professor Passerini, in East Liguria, on dry dead shoots and tendrils of the vine. Although the tubercles are described as somewhat rough, and the gonidia as being only 3–5 septate, still there is a general agreement. The deep depression in the berries is very marked, seemingly caused by the action of the fungus. It was considered by the discoverer to be the conidial stage of *Nectria viticola*, B. and C., and certainly the tubercles of the Fusarium were found surrounding the perithecia of the Nectria. At Ardmona the conidia occurred alone. (Fig. 50.)

12. NIPPLE-LIKE CYTOSPORA.

(*Cytospora mammosa. McAlp.*)

External Characters.—Pustules gregarious, minute, black, for a long time covered by epidermis, at length erumpent, dark-green by transmitted light.

Microscopic Characters.—Hyphæ ramifying in tissues, hyaline, septate, branched, $2–3\mu$ broad.

Perithecia spherical, hemispherical, or nipple-shaped, $\frac{1}{4}$ mm. in diameter, or about $350 \times 280\mu$; wall formed by coalesced hyphæ filaments and yellowish within; either slightly erumpent or standing out prominently with two or more cavities at base producing sporules. Sporules hyaline, slender, allantoid, slightly curved, $5\frac{1}{2} \times 1\mu$.

Basidia radiating towards centre all round inside of wall, hyaline, simple, rod-like.

Occurrence.—On ripe grapes. February–April, 1897. Ardmona. (Robinson, 191.)

Remarks.—This form is fairly common, but not likely to do much harm. At first a pale greenish mass bursts through the cuticle, composed of delicate hyphæ loosely interwoven around the margin, but more consolidated within. Then one large cavity is formed or several cavities at the base of the larger projecting masses, in which sporules are developed. The structure approaches nearest to *Cytospora*, and I have accordingly placed it in that genus. Several species are recorded on the dead branches of the vine, but none agree with the above, (Figs. 51–53.)

13. SLENDER-STALKED HENDERSONIA.

(*Hendersonia tenuipes. McAlp.*)

External Characters.—Pustules gregarious, hemispherical, erumpent, black, seated on depressed discoloured patches, occupying one side of soft and shrivelled berry, and surrounded by distinct ridge.

Microscopic Characters.—Mycelial stroma composed of delicate hyaline hyphæ, in which oval or somewhat spherical perithecia are formed, the compact walls of which are often coloured yellowish-green or dark-brown, and from which closely-packed basidia radiate, bearing the sporules. Loose hyphæ also occur, hyaline, septate, branched, sinuous, with finely granular contents, average breadth 2μ.

Sporules at first hyaline, oval, or somewhat spherical, unicellular, finally yellowish-brown, fusiform, 4 or 5 celled, usually 4, median cells coloured, terminal cells colourless or pallid, average $20–24 \times 6\frac{1}{2}\mu$. A slender, hyaline, stalk-like portion detached with sporule about 1μ broad.

Basidia arising from pseudo-parenchymatous wall of cavity, hyaline, very sparingly septate, contents sometimes highly vacuolated, $1–2\mu$ broad.

Occurrence, &c.—On ripe berries, but very rare. April, 1897. Ardmona. (Robinson, 195.)

Remarks.—While the normal sporule has two median brown cells and pallid terminal cells, there is considerable variation. The basal cell may be colourless and the succeeding two or three coloured, or there may be a single central coloured cell and the rest uncoloured.

This species resembles *H. longipes*, B. and C., found on dead branches of *Vitis* in the United States, in the long and slender pedicels of the sporules, but the perithecia are not free and the sporules are not oblong.

Hitherto species of *Hendersonia* have only been met with on branches of the vine, and Viala states in his " Les Maladies de la Vigne " " that these species are not parasitic, and develop only on the bark of annual shoots when they are no longer in a state of normal activity." But there is every reason to believe that this species found on the ripe grape causes disorganization of the tissues, and is a true parasite, although rare as yet. (Figs. 54–56.)

14. VINE ALTERNARIA.

(Alternaria vitis. Cavara.)

General Characters.—Forming compact greyish patches in depressions on surface of shrivelled-up grapes still attached to vine, also appearing on upper surface of leaves as greyish effused patches presenting innumerable black points.

Microscopic Characters.—Hyphæ greenish in mass, greyish or greenish-grey individually; creeping hyphæ nodulose, densely crowded in patches, with outstanding, tufted, sparingly branched, septate hyphæ, 4–6 μ diameter, bearing conidia.

Conidia greenish to brownish, in chains, deciduous, readily germinating, variously shaped, elongated, ovate to clavate, stalked or stalkless, 20–56 × 10–20 μ, stalk up to 41 × 3 μ.

Occurrence, &c.—On Champion Muscat grapes. March. Doncaster.

On leaves of Gordo Blanco and other vines. May. Ardmona (Robinson, 202.)

Remarks.—This Alternaria is very probably a saprophyte on the grape, attacking the berries when shrivelled up from some other cause, but on the leaf it is at least sometimes parasitic. It differs from A. *vitis*, Cavara, found on the upper surface of the leaves in the narrow hyphæ and the broader spores, but these characters are not considered sufficient to separate it from this form.

In some cases the attachment of the conidia is somewhat firm, as they are occasionally not detached by gentle pressure. (Figs. 57–59.)

15. BROWN LEAF-SPOT.

(Phyllosticta vitis. Sacc.)

External Characters.—Spots irregularly rounded, with distinct margin, brown, very frequently near larger veins of leaf, with numerous, black, punctiform pycnidia on upper surface.

Microscopic Characters.—Hyphæ pale-yellow to colourless, septate, branched, varying in diameter from 2 to 5½ μ; perithecia gregarious, globose, chestnut-brown, mouth papillate, 140–230 μ in diameter.

Sporules colourless, cylindrical, rounded at both ends, average 6½ × 2 μ.

Occurrence, &c.—On living leaves of grape vine. May. Ardmona. (Robinson, 201.)

Remarks.—Associated with *Alternaria vitis*, Cav. A perithecium was observed with two distinct pores near each other. This species generally agrees with P. *vitis*, but the spots are not sinuous and indefinite; the perithecia are much larger, and the sporules are slightly narrower. The perithecia developed on the brown spot, after being kept moist for about three weeks under a bell-jar. (Fig. 60.)

II.—SAPROPHYTES.

16. FIBRILLARIA.

(*Fibrillaria xylothrica. Pers.*)

Mr. Francois de Castella sent me from Tongala in September, 1895, specimens of a peculiar minute fungus found on dead shoots of the vine, and on the exfoliated bark of two-year old wood. I described it as follows :—Minute, white, circular cushions, with depression usually in the centre, distinctly visible to the naked eye, and in clusters consisting of innumerable, radiating, transparent filaments, with rounded ends and roughened walls, sometimes enclosing yellowish-brown jointed filaments, occasionally branched.

On submitting specimens to Professor Viala, of Montpellier, he informed me that it was a species of *Fibrillaria*. Mr. de Castella also found it on a rose and a honeysuckle tangled up with vines, and I have met with it in my own garden on the bark of a vine, as well as on the dead branch of a lemon.

This is considered by Viala as the sclerotium of *Psathyrella ampelina*, Foex and Viala, since it was obtained by sowing the spores of that fungus. It is satisfactory to know that it lives exclusively on portions of the vine already dead, and is therefore a saprophyte. The hyaline filaments are often covered with minute asperities which gives them a hirsute appearance, and these are more numerous the more fully developed the filaments are. From the action of acids these asperities are considered to consist of oxalate of lime. Various spores are often entangled among the filaments, and the yellowish-brown hyphæ often found associated may belong to distinct fungi. (Figs. 61–63.)

17. GREGARIOUS CATHARINIA.

(*Catharinia gregaria. McAlp.*)

Microscopic Characters.—Perithecia more or less oval, depressed-globular, at first immersed, then more or less erumpent, black, gregarious, with minute papillate pore, 130–150 × 112–130 μ.

Asci elongated-clavate, shortly-stalked, hyaline, united in tufts, 8-spored 94–98 × 19 μ. Paraphyses slender, simple, jointed, tapering, and becoming flexuous towards tip, 2 μ broad.

Sporidia hyaline, oblong or somewhat fusoid, 4-septate, with vertical septa in two or three of the divisions, usually constricted at septa, one-rowed, 24–30 × $7\frac{1}{2}$–9 μ.

Occurrence, &c.—On exfoliated bark of vine. October, &c. Near Melbourne.

Remarks.—This is evidently a Pleospora with hyaline spores, and I have placed it in the genus *Catharinia* constituted by Saccardo in 1883.

It differs from *C. hyalospora*, Speg., found on dead branches of the vine, in the perithecia being scattered in the latter, $\frac{1}{3}$–$\frac{1}{2}$ mm. in diameter, and the sporidia being only 3-septate horizontally. (Figs. 64–67.)

18. OLIVACEOUS PLEOSPORA.

(*Pleospora olivacea. McAlp.*)

Microscopic Characters.—Perithecia black, shining, smooth, punctiform, scattered. Asci clavate or cylindrical-oblong, tapering into short curved pedicels usually dilated at point of attachment, hyaline, thick-walled (2–3 μ) 4–8 spored, 80–100 × 15–17 μ. Sporidia clear olivaceous or yellowish-green, pear-shaped to elongated-oval, obtuse at both ends, 5-septate, usually with a few longitudinal septa, not constricted, arranged mostly in two rows, but one-rowed at either end of ascus, 17–22 × 8–9½ μ, average 18 × 8 μ.

Very slender, jointed, simple paraphyses.

Occurrence.—On exfoliated bark of vine. October, &c. Near Melbourne.

Remarks.—The Ascus is at first filled with a finely granular protoplasm definitely marked off by the thick outer wall. Then the contents become differentiated into sporidia which are at first colourless, but at maturity acquire a rich clear olivaceous tint.

In *P. vitis* the asci are longer, the sporidia nearly double the length and breadth, and the septa are more numerous. In the common *P. vulgaris* the sporidia are constricted, most deeply in the middle, and the four middle cells usually have one vertical septum. (Figs. 68–71.)

19. COOKE'S ASPERGILLUS.

(*Aspergillus cookei. Sacc.*)

External Characters.—The affected berries are covered with a very dark-purple layer, quite powdery on the surface from the detached conidia.

Microscopic Characters.—Mycelium white, intricately interwoven. Conidiophores erect, hyaline, continuous, crowned with a large globose vesicle. Basidia short, cylindrical. Conidia for a long time persistent, globose, brown, 4 μ diameter produced in chains, forming a globose black capitulum.

Occurrence, &c.—On ripe grapes. April, 1897. Ardmona. (Robinson, 196.)

Remarks.—This species has only hitherto been recorded on decaying plants and leaves, but in this case it was common on otherwise healthy fruit remaining on the vines, suggesting that it was parasitic in its nature. The above description is given from Cooke's "Handbook of Australian Fungi," p. 369.

20. BLACK STERIGMATOCYSTIS.

(*Sterigmatocystis nigra, V. Tiegh.*)

External Characters.—Forming a blackish-green incrustation, with numerous little brownish to blackish balls, on fruit-stalks, as well as on the berry itself.

Microscopic Characters.—Fertile hyphæ erect, 800–1,000 × 11–16, μ, thick-walled, hyaline or slightly darkened beneath globose head; mycelium composed of more slender hyphæ; head sub-globuse from black to brown; basidia 40 μ long, radiating; sterigmata 8 μ long, obclavate; conidia globose 3–4½ μ, warty, from violet to brown, in chains.

Occurrence, &c.—On grapes and stalks. January. Near Fremantle, West Australia. (Despeissis.)

Remarks.—Some diseased grapes were sent to me from West Australia towards the end of January by Mr. Despeissis. The few vines affected grew close to a swamp or with water within a few feet of their roots. The berries had the whitish appearance sometimes caused by the Aureo Grape-rot; but, on examination, no trace of that fungus was found. "Blue Mould" and a species of Mucor and the above fungus were, however, found.

The microscopic description is taken from Saccardo's "Sylloge Fungorum." The creeping hyphæ were colourless, septate, branched, with granular contents, 4–5 μ broad, and the conidia were on an average 4 μ in diameter.

21. TWO-COLOURED PENICILLIUM.

(*Penicillium bicolor, Fr.*)

External Characters.—It forms an effused sulphur-yellow patch on the surface of the ripe fruit, and in white grapes the tissue invaded by the mycelium becomes more or less pink.

Microscopic Characters.—Sterile hyphæ effused, yellowish; fertile hyphæ more or less fasciculate, apex penicillately branched; conidia sub-globose, about 4 μ diameter borne in chains at the tips of the branchlets.

Occurrence, &c.—On decaying grapes. March-April. Ardmona. (Robinson, 197.)

Remarks.—This fungus was first found in 1895, and always on grapes, while in Britain it occurs on various decaying substances. The microscopic characters are taken from Massee's "British Fungus-Flora," Vol. III.

22. GRAPE CLADOSPORIUM.

(*Cladosporium uvarum. McAlp.*)

External Characters.—Forming conspicuous, olive-green, effused patches on berries dried up and shrunken, and consisting of a dense mass of convoluted hyphæ.

Microscopic Characters.—Hyphæ in tissue stout, nodulose, septate, branched, yellowish-green to brownish, 4–15 μ broad, averaging about 6 μ, and forming enlarged cells here and there, which probably act as resting-bodies during the winter. These resting-bodies are of a yellowish-green colour, of various shapes and sizes, but mostly round to oval, and may measure about 24 × 19 μ.

Conidiophores dark-green in mass, pale-green separately, septate, usually rounded at free end and often tapering and becoming pallid, 5½–6 μ broad. Conidia with brown walls and contents olive-geen, continuous 1- or 2-septate, hardly constricted at septa, smooth, produced terminally, rounded at both ends or slightly pointed, variable in size and shape, round, oval, ovoid, cylindrical, or pear-shaped, average 10–19 × 4–9 μ.

Occurrence, &c.—On ripe grapes. February–May. Ardmona. (Robinson, 154.)

Remarks.—This species forms dense nodules, sometimes 2 mm. thick in the interior of the grape, which is dried up.

It differs from the common and very variable *C. herbarum*, Link, in forming these nodular masses and in the presence ef numerous resting-bodies. It probably causes drying up and shrivelling of the grape, but for the present it is regarded as a saprophyte. (Figs. 72–74.)

23. VELVETY MACROSPORIUM.

(*Macrosporium velutinum McAlp.*)

External Characters.—Forming a dark olive-green effused velvety layer, surrounded by a glaucous bloom, generally starting from crack on depressed portion of ripe berries, also on dried-up portions.

Microscopic Characters.—Tufts numerous, gregarious, olivaceous to brownish.

Creeping hyphæ pale-green, closely septate, much branched, nodulose or angular divisions often forming a close-set pavement.

Conidiophores darker in colour, sub-erect, crowded, septate, not constricted at septa, sparingly branched, rounded at free ends, 75–140 × $4\frac{1}{2}$–5 μ.

Conidia generally same colour as conidiophores, 1–8 septate and often longitudinally divided, at first a-septate, slightly constricted at septa, obovate to elliptic-clavate, attenuated towards base and frequently pedicellate, 20–64 × 8–15 μ.

Occurrence, &c.—On ripe grapes. March–May. Ardmona. (Robinson, 150.)

Remarks.—From its mode of occurrence this species is probably a saprophyte. It differs from *M. uvarum*, Thuem, in the conidia when uniseptate not being constricted in the middle, when multiseptate in being elongated—and not globoso-clavate, and in being sometimes more than double the length and breadth. It differs from *M. vitis*, Sorok., in the conidia not being grey, being twice as long and much more slender. (Figs. 75–79.)

24. BARK HENDERSONIA.

Hendersonia sarmentorum. West.)

External Characters.—Forming closely crowded, numerous, small round, immersed, black punctiform bodies on the dead bark.

Microscopic Characters.—Pustules gregarious, immersed, blackish, Sporules ellipsoid or irregularly oblong, triseptate, brown, 10–14 × 5–$5\frac{1}{2}$ μ.

Occurrence, &c.—On dead bark still attached to stem of Champion Muscat. March. Doncaster.

Remarks.—This species is common wherever the vine is cultivated, and is sometimes mistaken for "Dotted Anthracnose," but it is not a parasite like the latter. The sporules are of a clear brown colour, with dark relatively thick septa, and sometimes one or both of the end cells are transparent. (Fig. 80.)

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TREATMENT OF THE PRINCIPAL FUNGUS DISEASES OF THE VINE.

PARASITIC FUNGUS.	PARTS ATTACKED.	GENERAL APPEARANCE.	PREVENTIVE MEASURES.		DETAILED TREATMENT.
			GENERAL.	SPECIAL.	
1. Anthracnose or Black Spot ... (*Sphaceloma ampelina.*)	All green parts, shoots, leaves, flowers, and fruit	Discoloured dry sunken spots, circular or oval, either separate or run together, usually with a black margin	Collect and burn all diseased fruit: cut off and burn all diseased wood	Apply sulphuric acid as directed in winter. Bordeaux Mixture	Sulphuric Acid.—Take one part by weight of sulphuric acid (concentrated) and ten parts by weight of water. (A gallon of water weighs 10 lbs.) Add the acid slowly, stirring gently at the same time. After pruning apply the mixture to the wood of the past two seasons with a hog bristle brush at the end of a long handle, like a tar brush. Cost of treatment at Rutherglen, for material and labour, 7s. 1d. per 1,000 vines. Bordeaux Mixture.—Spray just before bursting of buds, and in wet springs when grapes are as large as peas.
2. Oidium or Powdery Mildew ... (*Oidium Tuckeri.*)	Young shoots, leaves, flowers, and berries	Powdery or mealy appearance, even on shoots when bad	... ...	Sulphur or Bordeaux Mixture, or ammoniacal copper carbonate	Sulphur may be applied when the shoots are about 4 inches long, and at intervals according to the season; sulphuring at time of bloom, shortly before and shortly after, is recommended. Bordeaux Mixture may be used in preference to sulphur, and is largely superseding it in France. Sulphur may then be used only at blooming season.
3. Sweet Rot or Noble Rot .. (*Botrytis cinerea.*)	Seedlings, young shoots, leaves, and fruit	Covering surface of berries and even whole bunches with ashy-grey or olive-grey tufts, usually run together	Clean culture, drainage; burn diseased portions; do not allow diseased fruit to remain on the ground	Bordeaux Mixture might be tried. Spraying with solution of potassium sulphide is also recommended, half-an-ounce dissolved in a gallon of water. Spray first when the leaf-buds are expanding	
4. Aureo Grape-rot ... ... (*Aureobasidium vitis, var. tuberculatum.*)	Berries and fruit-stalks ...	Berries always very soft, skin easily lifted, white, brown, or somewhat greenish, on black grapes reddish-purple	Destroy all diseased fruit; never allow it to remain on the ground; hoe or dig round vines in winter	... ...	Experiments are being conducted to ascertain satisfactory course of treatment, but in the meanwhile recommend that Bordeaux Mixture or ammoniacal copper carbonate be employed shortly before ripening, as these diseases do not become bad till then.
5. Squirt Berry ... ... (*Phoma tuberculata.*)	Berries	Minute bluish-grey dots on greyish area; skin very tender, easily broken			
The two following diseases are supposed to exist in the colony:—					
Black Rot ... ... (*Guignardia Bidwelli.*)	Young shoots, leaves; and berries	On the shoots dark oval areas slightly sunken and studded with small pimples. On the leaves reddish-brown rounded spots between principal nerves. Berries ultimately black and shrivelled	Collect and burn all diseased fruit; cut off and burn all diseased wood	Bordeaux Mixture	Spray—1st. Before bursting of buds; 2nd. When leaves are about one-third grown. 3rd. Just before flowering. According to the season further applications may be made after blooming and until the berries are three-quarters grown. For the later applications, to prevent discolouration of the fruit, the ammoniacal copper carbonate may be used.
Brown Rot or Downy Mildew ... (*Plasmopara viticola.*)	Young shoots, leaves, and berries	Grey frost-like mould on lower surface of leaves. Berries turn brown and become covered with whitish powder	Leaves should not be allowed to remain on the ground from year to year, they perpetuate the disease	Bordeaux Mixture	Same as for Black Rot.

BORDEAUX MIXTURE, Ordinary Form.

Copper sulphate (bluestone) 6 lbs.	For summer use add double the quantity of water
Quicklime (to be freshly slaked), 4 lbs.	
Water, 20 to 25 gallons ...	

Pulverize the bluestone and dissolve it in a wooden vessel in 4 gallons of hot water. Slake the lime in a small quantity of water so as to get it as fine as possible, then add to it the remainder of the 20 to 25 gallons of water. When both are cool, pour the latter slowly into the bluestone solution, stirring continuously and straining through coarse sacking or otherwise.

When a large area is under vines, and consequently a quantity of spraying material is required, then what are called stock solutions may be made use of. Bluestone Solution.—Dissolve, say, 1 lb. of bluestone for every gallon of water by suspending it just beneath the water in a coarse bag. If 50 gallons of water are used in a wooden cask, then 50 lbs. of bluestone will be required, and the solution can then be covered and the level of the water marked, so that any loss from evaporation can be made good. Whitewash.—Slake the fresh lime in the usual way and make a thick whitewash. Cover the vessel in which it is contained, and always replace loss from evaporation. 2 lbs. of lime may be used for 1 gallon of water. In order to make the mixture as above, take 6 gallons of the stock bluestone solution, which will of course contain 6 lbs. of bluestone, and make it up to 20 gallons with water. Then after stirring up the whitewash well so as to have it uniformly mixed, take out 2 gallons which will contain the equivalent of 4 lbs. of lime, make it up to 5 gallons with water, and strain if necessary while adding it to the bluestone solution. *Use the Bordeaux Mixture immediately after it is made.*

BORDEAUX MIXTURE.—Improved Form.

Copper sulphate	4 lbs.
Quicklime	4 lbs.
Molasses	4 lbs.
Water	25 gallons

Slake the lime as before, and when cool add the treacle to this and make up to about 20 gallons with water. Stir well and leave for a few hours, stirring at least once in the interval. Dissolve the bluestone in the remaining 5 gallons of water, and when cool decant the treacle-coloured liquid into the same vessel without allowing the sediment to pass, and the result is a beautiful greenish liquid ready for spraying.

AMMONIACAL COPPER CARBONATE.

Copper carbonate	5 ozs.
Ammonia (26°)	3 pints
Water	45 gallons

Mix the copper carbonate in a wooden pail with sufficient water to make a thick paste, next add the ammonia to dissolve the paste, and when all is dissolved dilute with water to make 45 gallons.

COMBINED INSECTICIDES AND FUNGICIDES.

Bordeaux Mixture and Paris Green.

Take 1 lb. of Blundell's or Lewis Berger and Son's Paris Green, make into a thin paste with water, and add it to 200 gallons of Bordeaux Mixture. Mix the two just before using, as if allowed to stand they may deteriorate.

Note.—As ammonia dissolves the arsenic in Paris Green, never use the ammoniacal copper carbonate with Paris Green.

QUOTATIONS FOR INGREDIENTS.

The following are the Melbourne prices quoted for the ingredients employed:—

Sulphuric acid, 3d. per lb., 60-lb. jars, 2d. per lb., jars, 3s. 6d.
Copper sulphate, 22s. 6d. per cwt.
Iron sulphate, 5s. per cwt.
Quicklime, 3s. 3d. per bag.
Paris Green, 10d. per lb.
Copper carbonate, 4s. per lb.
Ammonia (26° Beaumé), 1s. per lb. in 1-lb. bottles.
Flowers of sulphur, 8s. per cwt.
Molasses, 7s. 6d. per cwt., £7 5s. per ton.
Potassium sulphide, 1s. 3d. per lb.

N.B.—These quotations are subject to fluctuation, but special rates are given for large quantities.

GENERAL REMARKS ON TREATMENT.

The fungus diseases of the vine, which have been known for some time and studied in Europe and America, have been all more or less successfully treated, and the following will describe the methods which have yielded the best results:—

Bordeaux Mixture, properly and seasonably applied, is a good general remedy for fungus diseases, with the exception of those such as Anthracnose, which require special treatment, and it may be safely applied until the berries are about three-fourths grown. Then the ammoniacal solution of copper carbonate may be used, since it is perfectly clear and entirely free from sediment. The new diseases will, of course, require to be carefully watched and experimented on, in order to find out the best methods of treatment for them, but careful cultivation, burning of rubbish, judicious pruning, proper manuring, and the use of Bordeaux Mixture will tend to check, not eradicate, many of these diseases due to fungi.

In the *Chronique Agricole* for 10th May, 1897, just received, Professor J. Dufour treats of Oidium and Downy Mildew, and records the results of experiments during 1896, the summer of which, with its continuous rains and heavy dews, was particularly favorable for the development of such diseases.

For Oidium he considers that sulphuring before the leaves appear is absolutely necessary for vines very liable to the disease. Then, after the leaves have appeared, one or several sulphurings at suitable times, according to the progress of the disease. If the weather is showery a little lime should be added to the sulphur, since this mixture adheres better to the leaves than sulphur alone.

As regards the Downy Mildew, experiments absolutely confirmed the undoubted superiority of the ordinary Bordeaux Mixture, for of the six mixtures tried, and taking ten as the standard of efficiency, the Bordeaux Mixture had nine points. The formula used was—

Bluestone	6 lbs.
Lime	4 lbs.
Water	20 galls.

The Eau Céleste is recommended to be abandoned, because it is decidedly less efficacious and too easily washed off by rain. Besides it has a caustic action upon the foliage.

As regards Anthracnose the 10 per cent solution of strong sulphuric acid has proved very effective. A writer in the *Revue de Viticulture* observes that, after using this treatment for four years in his vineyard, there was no necessity to use sulphur for Oidium, because the fungus was completely destroyed, but others have found that the sulphuric acid treatment does not dispense with the necessity for sulphuring. The one objection raised against it is the injury done to the workmen's clothes, but this is easily obviated by the mode of application. Measure off the quantity of water required and add the acid slowly, stirring the solution at the same time, 1 lb. of strong acid being added to every gallon of water. Then apply with a hog's hair brush, placed at the end of a long handle and mounted like a tar brush. The workman or boy can do his work expeditiously and comfortably without stopping, and any spluttering of the acid solution is at too great a distance to reach his clothes. Different proportions were tried, but a 10 per cent. solution was found to be adequate and effective.

The remarks of Professor Trouessart on the Diseases of the Vine are worthy of attention. He says—"We may be surprised that this valuable plant, which has been so carefully cultivated in France, should be attacked by such a number of parasites, both animal and vegetable. Yet we should rather be surprised that the vine has not been completely destroyed by the combination of such diverse scourges, and that it has effectually resisted them in several regions of France. When we consider that for long years the same hoary old stocks have been required to produce grapes without truce or mercy, and often without taking pains to supply to them by a fitting manure the nourishment which is withdrawn from them by the fructification of the grape, we shall be less astonished at the decadence of our vineyards. And, indeed, enlightened minds ascribe the attacks of these numerous parasites to the weakness and exhaustion of our vines, rather than to any accidental cause, such as importation from without." Treatment for disease and manuring should go hand in hand, and this plan has been followed in the experiments conducted under my supervision by Mr. R. F. Gow, Abbotshall Vineyard, Rutherglen. A 3-acre patch of Shiraz, 37 years old, and said to be worn out and almost past bearing, was treated in 1895 with several artificial manures, and the results noted at the last vintage. One acre was treated with Albert's P.K.N.D. at the rate of 8 ozs. per vine, the cost and labour of applying it being 87s. 8d. per 1,000 vines, and the yield of grapes last vintage was 41 cwt. Another acre was treated with potash chloride at the rate of 10 ozs. per vine, the cost being 85s. 6d., and the yield 35 cwt. The third acre was treated with Thomas's phosphate at the rate of 10 ozs. per vine, and at a cost of 33s. 11d. per 1,000 vines for a yield of 40 cwt. The total return for the three blocks was 116 cwt. of grapes, which gave 435 gallons of wine per acre, whereas at the 1896 vintage the same land yielded only 79 cwt. of grapes for 263 gallons of wine per acre. Other parts of the vineyard bearing Shiraz, and where no manure was applied, produced a much smaller yield, even although the vines were younger and pruned and treated in exactly the same way. Fortunately for the vigneron, the vines during the past season in this district were practically free from disease, vigorous in growth, and prolific in yield, so that the effect of manuring upon disease was not observable, but the experiments will be continued this season with bone-dust and other manures added, when the relative amount and kind of disease in manured and unmanured plots will be carefully noted.

APPENDIX.

By Gerald H. Robinson.

Acting on the suggestion of Mr. McAlpine, I have prepared the following summary of the weather conditions existing at Ardmona during the years 1895, 1896, and part of 1897, covering the entire period in which investigations have been conducted on such of the vine diseases as were found there. The rainfall for each month is first given supplemented by general remarks.

	1895.		1896.		1897.	
January	1·82		0·62		1·92	
February	0·48	2·85	1·78	5·31	0·44	0·66
March	1·10		1·24		0·14	
April	1·27		2·29		0·08	
May	0·29	1·91	0·86	3·90		
June	1·20		2·16			
July	0·42		0·88			
August	1·73	4·20	0·62	3·67		
September	0·62		1·97			
October	1·85		1·08			
November	Nil		1·28			
December	1·03		1·09			
Total	11·81 inches		15·87 inches			

For the purpose of comparison, the totals for the grape season, February, March, and April, have been given, as well as two other periods of three months each.

The average rainfall at Tatura, 8 miles distant, where records have been kept for thirteen years, is 19·1 inches, but there is usually an excess of 1 inch per annum over that obtained at Ardmona.

During the first seven months of 1895, the rainfall was considerably below the average ; in fact, this period marks the commencement of the cycle of dry years from which we are still suffering. The spring rainfall was light, marked by a heavy fall of 1·82 inches on 2nd and 3rd of October, after which there was an interval of eight weeks absolutely rainless, terminated by a fair downpour early in December. Naturally, the growth of the vines was much interfered with by these abnormal conditions, and it is not surprising that the attacks of various diseases were severe, as soon as the rains commenced early in February, just as the Muscats were ripening. From this time till the end of the season frequent light rains were recorded. The peculiarity of this autumn was that the rain fell in such a way as to do the most harm to the vine-grower with the least benefit to the farmer. Heavy dews were of almost nightly occurrence, so that large quantities of fruit were destroyed. It has been estimated that within a radius of 3 miles from 5,000 to 10,000 cases of grapes (120 to 240 tons) remained on the vines at the conclusion of the season, having been attacked so severely that they were worthless for market purposes. The most common diseases were the "Squirt Berry," "Aureo Grape-rot," "Sweet Rot," and "Strumella."

Little serviceable rain was afterwards secured until 16th September, when 1·41 inches were recorded, followed by nearly nine weeks almost absolutely rainless, and terminated by a fall of rain of three-quarters of an inch on 16th November. December was normal, January, 1897, was marked by heavy cold winds, with more than the average rain. February was as usual dry, March extremely so, while the fall in April was the lowest ever recorded.

By comparing the total for February, March, and April of 1896 with same period in 1897, it will be seen what a great difference existed, sufficient to account for the fact that there was much less disease in the past season than in the previous one.

The "Aureo Grape-rot" was, however, very prevalent, although the "Strumella" was not met with. The dryness of the winter and spring of both years greatly retarded the growth of the vines, and no doubt the stunted growth and insufficiency of leaves, in 1896 especially, rendered the fruit an easy prey to the fungus parasites.

Effect of Irrigation.—The Ardmona district is situated within the area supplied by the channels of the Rodney Irrigation Trust. Comparatively few growers availed themselves of the artificial supply of water in the spring of 1895, but it was remarkable that there was far less disease on the irrigated areas. This was due no doubt, in part, to the protection from rain and dew afforded by the more numerous leaves, while greater vigour must also have been an important factor in securing this result. The usual belief is that irrigation tends to assist the spread of fungus diseases, and, although this is possibly true in ordinary years, yet it does not hold in periods of drought. Careful observations were made in the succeeding year as to the effects of irrigation. It was remarkable how general was the application of water in the early spring of 1896, some growers preferring to irrigate only once before the blossoming period, others twice, the second after the fruit had set. The latter method was very successful in securing large crops of good fruit, but where three irrigations were employed, the last late in December, too many laterals were produced, and a little "black spot" could be found on the second crop. It may be regarded as certain that judicious winter or early spring irrigation in dry seasons is of marked benefit, but late waterings will probably be found to accelerate the spread of Black Spot and Oidium as well as other diseases.

EXPLANATION OF PLATES VII.-X.

COREMIUM GLAUCUM—

Fig. 40. Cup-shaped form—natural size and slightly magnified. The thickened upper portion is sage-green, with penicillately branched conidia-bearing hyphæ, projecting at Surface. All the rest including the tips and outer portion of the rim is composed of snow-white filaments.

CLADOSPORIUM ROESLERI—

Fig. 41. Portions of hyphæ (× 1,000).
Fig. 42. Conidia attached (× 1,000).
Fig. 43. Conidia detached and in chains (× 1,000).

GLŒOSPORIUM BICOLOR—

Fig. 44. (See Plate II.)
Fig. 45. Sporules (× 1,000).
Fig. 46. Sporules of "Ripe-rot" for comparison (× 600).

FUMAGO VAGANS—

Fig. 47. Branching portion (× 270).
Fig. 48. Detached portions of hyphæ (× 1,000).
Fig. 49. Conidia attached and detached (× 1,000).

FUSARIUM VITICOLUM—

Fig. 50. Conidia detached (× 1,000).

CYTOSPORA MAMMOSA—

Fig. 51. (See Plate II.)
Fig. 52. Terminal end of hypha (× 1,000).
Fig. 53. Sporules (× 1,000).

HENDERSONIA TENUIPES—

Fig. 54. (See Plate II.)
Fig. 55. Terminal portions of hyaline basidia (× 1,000).
Fig. 56. Sporules (× 1,000).

ALTERNARIA VITIS—

Fig. 57. Portion of hypha (× 1,000).
Fig. 58. Conidia of various shapes and sizes (× 1,000).
Fig. 59. Conidia in tandem fashion (× 1,000).

PHYLLOSTICTA VITIS—

Fig. 60. Sporules (× 1,000).

FIBRILLARIA XYLOTHRICA—

Fig. 61. Piece of bark with white circular cushions (natural size and slightly magnified).
Fig. 62. A few filaments from cushion (× 145).
Fig. 63. Filament showing asperities (× 550).

CATHARINIA GREGARIA—

Fig. 64. Oval perithecium (× 270).
Fig. 65. Ascus with sporidia (× 1,000).
Fig. 66. Sporidia detached (× 1,000).
Fig. 67. Free end of paraphysis (× 1,000).

PLEOSPORA OLIVACEA—

Fig. 68. Group of asci, only two of which are mature (× 145).
Fig. 69. Immature ascus, showing granular contents (× 1,000).
Fig. 70. Mature asci, with sporidia (× 1,000).
Fig. 71. Detached sporidium and terminal portion of paraphysis (× 1,000).

CLADOSPORIUM UVARUM—

Fig. 72. Intercellular hyphæ (× 1,000).
Fig. 73. Resting-body (× 1,000).
Fig. 74. Conidia at various stages of development (*a*, × 1,000, *b*, × 550).

MACROSPORIUM VELUTINUM—

Fig. 75. Creeping hypha with upright hyphæ at end (× 1,000).
Fig. 76. Sub-erect hyphæ (× 270).
Fig. 77. Portion of slightly branching hypha (× 1.000).
Fig. 78. Terminal end of hypha with unicellular conidium (× 1,000).
Fig. 79. Conidia of different sizes and shapes (× 1,000).

HENDERSONIA SARMENTORUM—

Fig. 80. Sporules (× 600).

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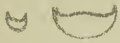
PLATE 7.

Fig. 40



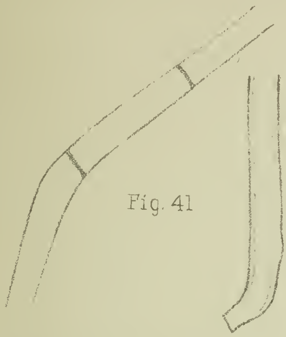


Fig. 41

Fig. 42

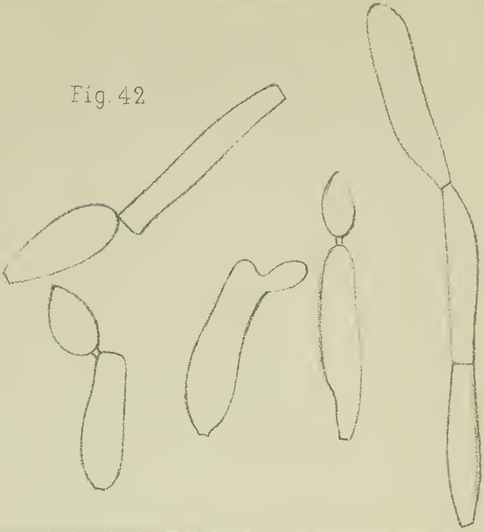
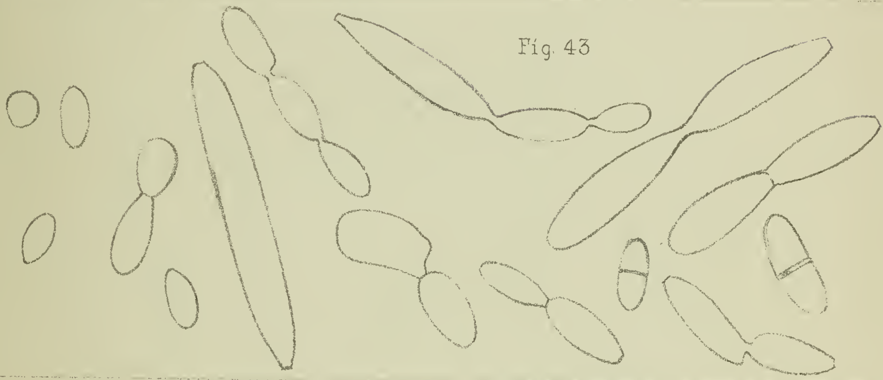
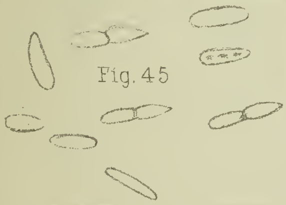


Fig. 43





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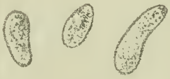

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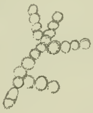

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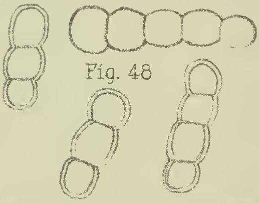

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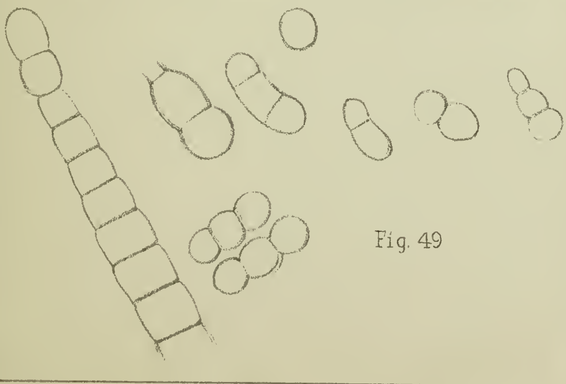

Fig. 49

Fig. 50

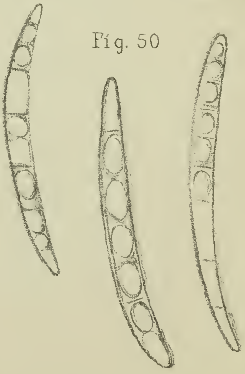

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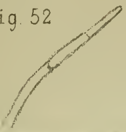
PLATE 8.

Fig. 52



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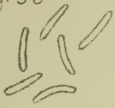

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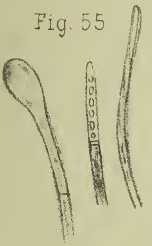

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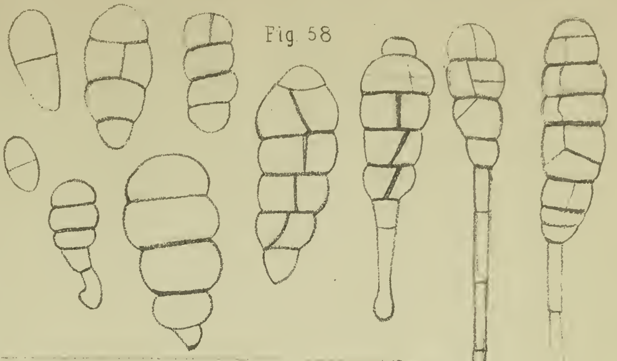

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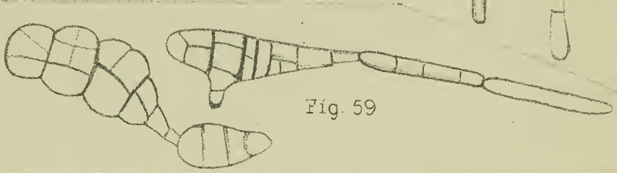

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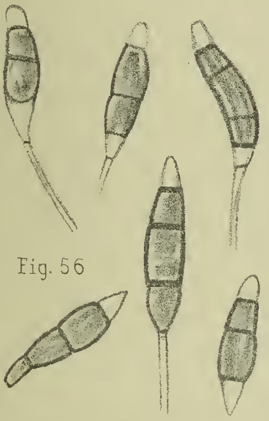

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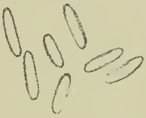

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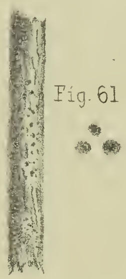

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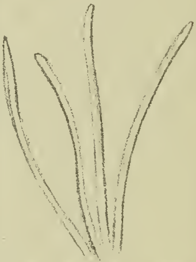

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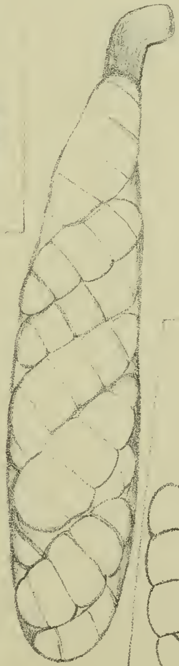

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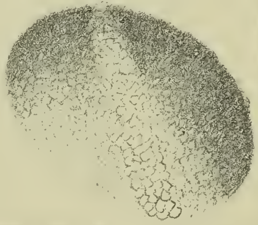

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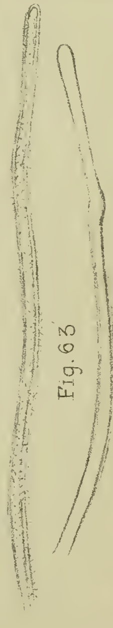

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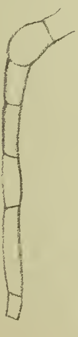

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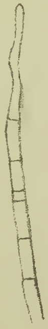

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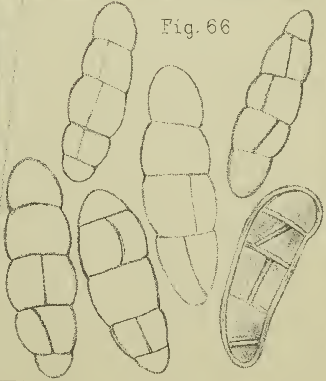

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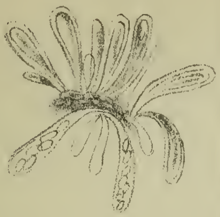
Fig. 68



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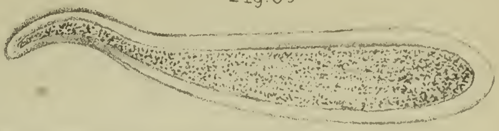

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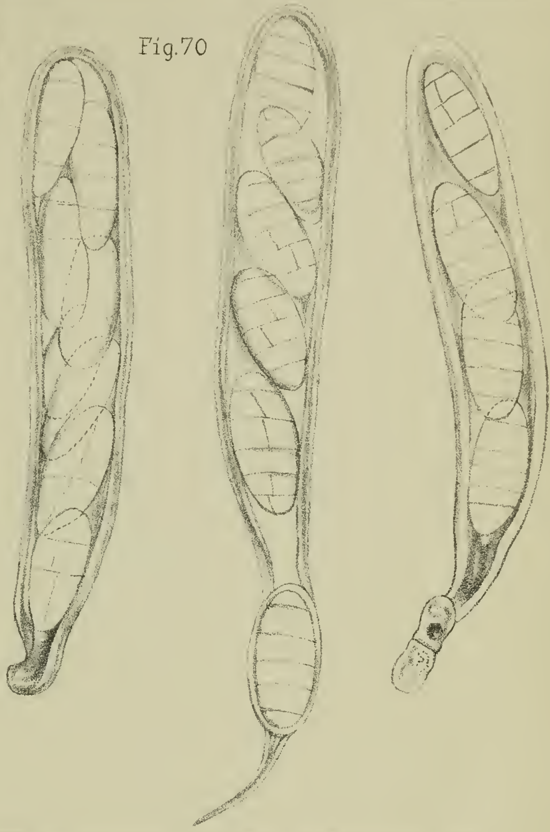

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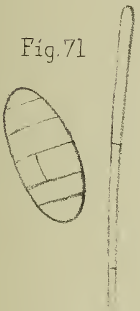

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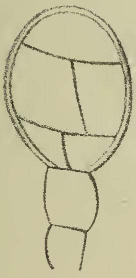

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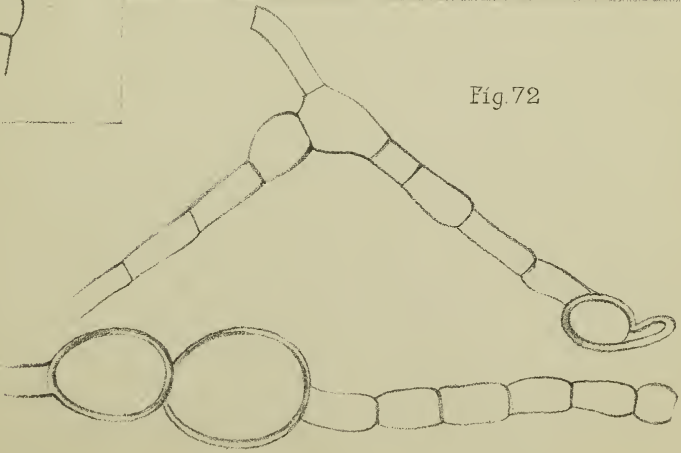

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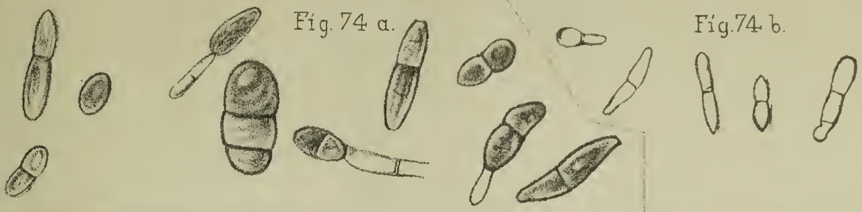


Fig. 74 a.

Fig. 74 b.

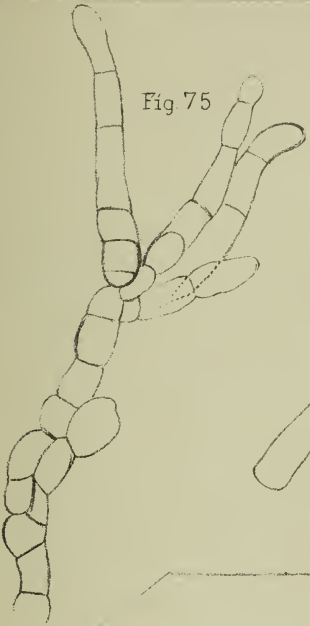
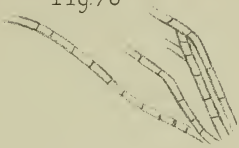


Fig. 75



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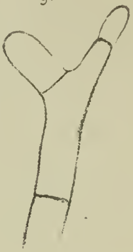

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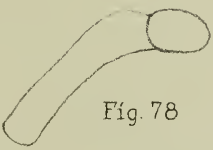

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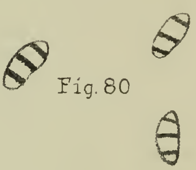

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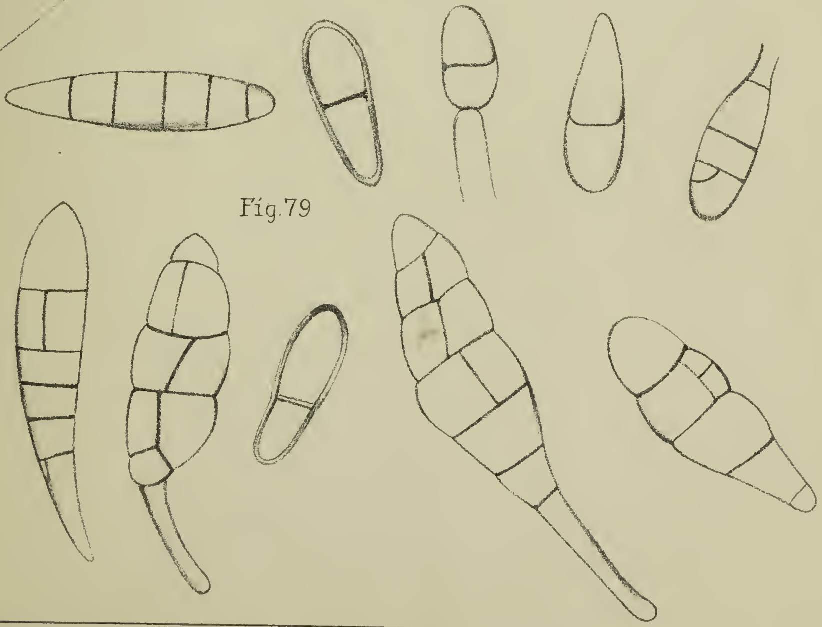

Fig. 79

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